Studies on Pacific Salmon (Oncorhynchus spp.) in Phase I of the Salmonid Enhancement Program

Volume I: Summary

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VOLUME I: SUMMARY

by

B.G. Shepherd, J.E. Hillaby and R.J. Hutton

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ABSTRACT

Shepherd, B.G., J.E. Hillaby and R.J. Hutton. 1986. Studies on Pacific salmon *(Oncorhynchus* spp.) in Phase I of the Salmonid Enhancement Program Volume I: SUMMARY. Can. Tech. Rep. Fish. Aquat. Sci. 1482: vii +pp 1-180.

From 1977 to 1984 the New Projects Unit initiated 38 field studies on wild salmon stocks throughout British Columbia, in order to develop biological design criteria for proposed enhancement projects. The purpose of this report is to make the data from these studies more easily available to other users. Pertinent biological data were extracted from the individual field studies, and adjusted where necessary to make the data as consistent as possible for comparative purposes.

Data are presented on migration timing, distribution and abundance of adults and juveniles; spawner characteristics such as sex ratio, age, length at age, fecundity, egg retention rates, flesh colour, and incidence of diseases; and length, weight and condition factors of juveniles. Physical characteristics of stream habitat important for spawning and rearing of wild salmon are also reviewed. These data are tabulated by stream and stock in Volume II; Volume I overviews the information by species and region, and provides perspective on factors which may have affected the findings.

RÉSUMÉ

Shepherd, B.G., J.E. Hillaby and R.J. Hutton. 1986. Studies on Pacific salmon *(Oncorhynchus* spp.) in Phase I of the Salmonid Enhancement Program Volume I: SUMMARY. Can. Tech. Rep. Fish. Aquat. Sci. 1482: vii + pp 1-180.

De 1977 à 1984, la section des nouveaux projets a amorcé 38 études sur le terrain portant sur des stocks de saumons sauvages. Ces études effectuées à l'echelle de la Colombie-Britannique ont pour objectif la détermination de critères biologiques de conception pour des projets de mise en valeur. Le rapport vise à rendre les données de ces études plus accessibles aux autres utilisateurs. Les données biologiques pertinentes ont été tirées des rapports et ajustées selon les besoins afin de les rendre les plus cohérentes possibles aux fins de comparaison.

Les données portent sur le moment des migrations, la distribution et l'abondance des adultes et des juvéniles, certaines caractéristiques des geniteurs comme le sex ratio, l'âge, la longueur selon l'âge, la fecondité, le taux de rétention des oeufs, la couleur de la chair et l'incidence des maladies, de même que sur la longueur, le poids et la condition des juvéniles. On traite aussi des caractéristiques physiques des habitats en cours d'eau importants pour le frai et la croissance des saumons sauvages. Les données sont présentées sous forme de tableaux, par cours d'eau et stocks, dans le Volume II. Le Volume I contient les renseignements sur les espèces et les régions et met en perspective les facteurs qui ont pu influer sur les résultats.

INTRODUCTION

The primary objective of the Salmonid Enhancement Program (SEP) is to boost the production of Canadian Pacific salmonids up to the potential yield levels experienced in the early 1900's. Planning for SEP began in 1975. From 160 candidate projects, phased schedules of reconnaissance, feasibility, construction, operation, and assessment activities were developed (Anon. 1978). Within the SEP organization, the New Projects Unit was assigned responsibility for the gathering of bioreconnaissance data to a level adequate to support facility design (see Shepherd 1984 for further details of SEP and the role of the New Projects Unit).

During Phase I (1977 to 1984) of SEP, almost 60 consultant and in-house reports were completed for the New Projects unit; over 40 of these reports contain new data on adult or juvenile salmon and their habitat from some 70 streams scattered throughout British Columbia (Tables 1 to 3). Eight studies of a developmental nature were also commissioned and included in the source report listing contained in Appendix A. These studies examined *Ceratomyxa shasta* in the Fraser River (53, 55, 59); hatchery effects on homing, straying and survival (25, 26), water quality criteria (58) and hatchery aeration systems (52, 66). Most of these studies were contracted to consulting firms, and to date the results have been lodged in the contractors' project reports, which have had only limited distribution. These reports collectively represent a significant body of field data on British Columbia salmon, which has been collected in a relatively consistent manner. Some of the reports have already proven useful to other groups in their reviews of port expansion and logging plans (U. Orr, DFO Prince Rupert, pers. comm.) and basic biology (Beacham 1982; Taylor and Larkin 1986). This report provides a summary compilation of that pool of data, together with some overview comments and observations. It is not our intention to provide exhaustive analyses of the data, but rather to promote a wider awareness and use of the data.

This report contains summarized results of a large number of field studies and consequently the referencing system has been adapted to avoid encumbering the text and duplicating the reference list. The source reports have been distinguished from other references cited and are referred to by number, in accordance with the chronological listing in Appendix A-1. Other references are described by author and year and are listed in a conventional manner in REFERENCES CITED.

Although there generally were less than 100 copies made of each consultant report, all reports are available on microfiche upon request to the New Projects Unit and printed copies may be found in Department of

Table 1. Bioreconnaissance studies of salmonid populations in the NORTH COAST area, 1977 to 1984.

Watershed	Species[a] Target[b]	Species[a] Incidental[c]	A/J[d]	Study Years	Reference[e]
Mathers	CM	---	A	1978	2
Mathers	CM	---	J	1979	4
Mathers	CM	---	A	1979	7
Morice	CN	CO	A,J	1978-1980	56,57
Kemano	CM	---	A	1979	19,20
Kitimat, Kildala Arms (Kitimat, Bish, Kildala, Dala, Falls)	CM	CN,CO	J	1981	27,28
Kitimat	CM,CN,CO	PK	J	1980	11,12
Gardner Canal (Kitlope, Kapella, Gamsby Tezwa, Kalitan, Kowesas, Tsaytis)	ALL	---	A	1981	46,47
Burke Channel (Kwatna, Quatlena, Nootum)	CO,CM,PK	---	A	1983	64,65

---

[a] Species: chinook (CN); coho (CO); chum (CM); sockeye (SK); pink (PK).

[b] Species which the field studies were intended to intercept. Study location, timing and strategy were designed to obtain maximum information for target species.

[c] Species for which data were gathered opportunistically. Data on incidental species may be incomplete due to inappropriate field study location, timing or strategy.

[d] A=adult studies; J=juvenile studies.

[e] Source reports are listed in Appendix A-1 by reference number.

Table 2. Bioreconnaissance studies of salmonid populations in the SOUTH COAST area, 1977 to 1984.

Watershed	Species[a] Target[b]	Species[a] Incidental[c]	A/J[d]	Study Years	Reference[e]
Little Qualicum	CM	CN,CO,SK	J	1979	5
Little Qualicum	CM	---	A	1978	1
Tlupana Inlet (Sucwoa, Canton, Conuma, Tlupana, Deserted)	CM	CN,CO,SK,PK	A	1978	3
Tlupana Inlet (Sucwoa, Canton, Conuma, Tlupana, Deserted)	CM	CN,CO,SK,PK	J	1979	6
Nitinat	CM	CN,CO	A	1979	10
Kakweiken	PK	CM,CO,SK	A	1981	31,32
Knight Inlet (Tom Browne, Glendale Mussel, Ahnuhati, Franklin, Kwalate)	ALL	---	A	1981	30
Knight Inlet (Tom Browne, Glendale Mussel, Ahnuhati, Klinaklini)	ALL	---	A	1983	60,61
Glendale, Tom Browne	PK	CO,CM	J	1983	67

[a] Species: chinook (CN); coho (CO); chum (CM); sockeye (SK); pink (PK).

[b] Species which the field studies were intended to intercept. Study location, timing and strategy were designed to obtain maximum information for target species.

[c] Species for which data were gathered opportunistically. Data on incidental species may be incomplete due to inappropriate field study location, timing or strategy.

[d] A=adult studies; J=juvenile studies.

[e] Source reports are listed in Appendix A-1 by reference number.

Table 3. Bioreconnaissance studies of salmonid populations in the FRASER RIVER area, 1977 to 1984.

Watershed	Species[a] Target[b]	Incidental[c]	A/J[d]	Study Years	Reference[e]
Quesnel, Horsefly, Nechako	CN	---	J	1979	8
Quesnel, Horsefly, Nechako	CN	---	A	1979	9
Quesnel, Blackwater, Cottonwood	CN	---	J	1980	16,17
Quesnel, Blackwater, Cottonwood	CN	---	A	1980	18
Bowron, Willow	CN	---	J	1980	21,22
Bowron, Willow Slim	CN	---	A	1980	23,24
Stuart	CN	---	J	1980	13,14
Stuart	CN	---	A	1980	15
Upper Fraser tribs. (Slim, Torpy, Morkill, Holmes)	CN	---	J	1981	44,45
Upper Fraser tribs. (Slim, Torpy, Morkill, Holmes)	CN	---	A	1981	42,43
Finn, Lion, Blue, Raft	CN	CO	J	1981	34,35
Finn, Lion, Blue, Raft	CN	CO	A	1981	36,37
North Thompson and tribs. (Finn, Raft, Clearwater, Joseph, Lemieux, Barriere)	CN	CO	J	1982	48

/ . . . continued

Table 3 (continued).

Watershed	Species[a] Target[b]	Species[a] Incidental[c]	A/J[d]	Study Years	Reference[e]
North Thompson tribs. (Albreda, Blue, Lion, Wire Cache, Lemieux, Barriere, Lious and others)	CO	---	A,J	1982	54
Adams, Eagle, Salmon	CN	CO	A	1981	40,41
Adams, Eagle, Salmon, Coldwater	CO	---	A	1982	50,51
South Thompson and tribs. (Eagle, Salmon, Adams)	CN	CO	J	1981	38,39
S. Thompson tribs. (Seymour, Perry, Crazy, South Pass, Tappen, Trinity)	CN,CO	ST	J	1982	49a,b
Middle Shuswap	CN	CO	J	1983	62,63

---

[a] Species: chinook (CN); coho (CO); chum (CM); sockeye (SK); pink (PK).

[b] Species which the field studies were intended to intercept. Study location, timing and strategy were designed to obtain maximum information for target species.

[c] Species for which data were gathered opportunistically. Data on incidental species may be incomplete due to inappropriate field study location, timing or strategy.

[d] A=adult studies; J=juvenile studies.

[e] Source reports are listed in Appendix A-1 by reference number.

Fisheries and Oceans (DFO) libraries in Ottawa, Nanaimo, and Vancouver.

The reader should also be aware that additional studies of a similar nature were continued into the 1984-1986 "transition phase" (see Appendix A-2 for details of these studies). Results from these studies have not been included in this report, as most were incomplete at the time of compilation. Water quality sampling results from New Projects studies undertaken during Phase I also have been reported separately (MacKinlay 1984).

SCOPE OF THE STUDIES

The primary purpose of this document is to make detailed biological data, gathered by the New Projects Unit, available to other users. This report is not intended to be an exhaustive comparative study. In presenting the data we have only briefly described obvious comparative points and provided an overall perspective on study requirements or background factors that may have affected the biological findings. In most cases, pertinent data were adjusted so that tabulated information is nsistent and suitable for comparative studies. The data are summarized the document and detailed in the appendices: conversely, the treatments plied to each parameter are detailed in specific sections of this document and summarized in the appendices.

Throughout this report, reference is made to regions, areas, watersheds, streams and years. Three "regions" are described: North Coast, South Coast and Fraser River. These refer to DFO administrative areas whose fish stocks also have some biological differences which are discussed in the following sections. "Areas" are primarily a geographic reference (eg. west coast of Vancouver Island) to indicate the relative proximity of a group of study streams. "Stream" is the study unit and usually represents a fish population whose characteristics were studied and reported on by the contractor. "Watershed" is self-explanatory and usually refers to tributary systems whose fish populations were studied separately (eg. South Thompson watershed). "Year" indicates the calendar year in which the field data was obtained, usually one year previous to the year the contractor's report was issued.

The scope of these studies was defined primarily by DFO staff knowledge of existing engineering and technical opportunities as well as an evolving process of fishery management planning which suggested development areas and therefore enhancement production goals (Schouwenberg et al. MS1980). Consequently, at a time when the Pacific fishing industry was characterized by increasing instability, poor economic performance and concern for declining fish stocks (Pearse 1982), fishery planning was necessarily conservative. Emphasis was placed on the development of stocks that could be discretely and efficiently fished, thereby directing biological studies to manageable areas and species. The following describes the overall priorities for the North Coast, South Coast and Fraser River regions.

NORTH

Large-scale sockeye production in the Babine system (West 1978) was recognized to have affected the Skeena commercial fishing harvest pattern by the late 1970's (Schouwenburg et al. MS1980). Overfishing through incidental catches of other stocks and species illustrated an overall need to not only control the level of enhanced fish production, but also to identify and enhance potentially intercepted stocks such as chinook salmon in the Morice River (56, 57). Geographic Working Groups were established in order to deal with the question of manageability of new enhancement projects (Shepherd 1984) and it was further decided that near-shore or terminal fisheries could be established through careful enhancement planning (Schouwenberg et al. MS1980).

The Management Unit concept was developed for several coastal areas, and was intended to enhance certain runs for targeted inlet fisheries (Table 1). Cumshewa Inlet was proposed for chum development and studies focused on the biological parameters necessary for hatchery production of that species (2, 4, 7). Subsequently, Kitimat Arm and Gardner Canal (11, 12, 27, 28, 46, 47) in Statistical Area 6 as well as Burke Channel in Statistical Area 8 (64, 65) were studied on a broader, multi-stock, multi-species basis that recognized inevitable mixed-stock fishery impacts, even in inside waters (Peacock et al. 1984).

These three areas all have favorable fishery management potential and were reasonably accessible. Studies were intended to clarify the abundance, timing and distribution of fish stocks in general, as well as generating more definite bio-engineering standards. The predominance of chum hatchery opportunities also resulted in juvenile estuarine studies being undertaken in order to fine-tune rearing technologies, especially in the Kitimat and Kildala estuaries (11, 12, 27, 28).

SOUTH

The application of the Japanese chum hatchery technique was the primary focus for bio-engineering studies in the South Coast, as existing chinook and coho hatcheries removed the need for emphasis on those species. Similar to the North Coast, the Management Unit approach was applied. During 1978 to 1980, studies on Tlupana Inlet chum streams as well as the Nitinat Lake area were done with terminal chum fisheries in mind (3, 6, 10). The Little Qualicum River studies were intended to increase the manageability of existing fisheries on Big Qualicum chum stocks, by development of incidentally-caught chum stocks, and therefore differed only in the enhancement technique applied (Schouwenberg et al. MS1980).

Subsequent studies during 1981 to 1983 for Knight Inlet stocks (30, 33, 60, 61) reflected a multi-species, multi-stock approach that evolved from the recognition of inevitable mixed-stock harvesting. These studies were undertaken at the same time as North Coast studies on the Kitimat, Kemano, Gardner and Burke channel areas.

FRASER

Interior Fraser River enhancement opportunities were based on the cautious development of chinook and coho salmon populations spread over several stocks and river systems. In contrast, projects in the lower Fraser River (downstream of Hope) initially focussed on chum enhancement opportunities established from chum studies in the 1960s (Palmer 1972) and Inch and Blaney pilot enhancement projects (Fedorenko and Bailey 1980; Banford and Bailey 1979). However, the multi-species, multi-stock concept was used increasingly in the lower Fraser area, especially in the latter half of Phase I, so that the Chilliwack and Inch expansion projects and Chehalis Hatchery all deal with several species and stocks. Since the International Pacific Salmon Fisheries Commission retained responsibility for the enhancement and management of sockeye and pink salmon in the Fraser River, enhancement of these species was deferred.

Therefore at the initiation of the Salmonid Enhancement Program, lower Fraser chum projects immediately entered the design and construction phase while biobaseline resources were directed towards interior chinook and coho stocks.

For conservation reasons, there was a further priority placed on early and mid-timing chinook stocks found in the upper Fraser River (Upper Fraser, Slim, Stuart, Quesnel, Blackwater, Bowron, Cottonwood, Horsefly, Willow). Studies on upper Fraser stocks predominated from 1979 to 1980, while from 1981 to 1983 the emphasis changed to North and South Thompson stocks and their tributaries (Table 3). Coho were targetted in the Thompson studies, with the intention of including them in hatchery production strategies. There are no significant coho runs in the Fraser River north of the Thompson River confluence.

OVERVIEW OF METHODS

These biological reconnaissance and feasibility studies were but one step in the process of selection and design of SEP Phase I major facilities. Shepherd (1984) outlines this process in greater detail and the following overview comments are taken from that publication. The reader is advised to check the methods sections of the individual studies for details of techniques and variations.

Biological Baseline Studies can be divided into two major activities: collation of existing data and generation of new data through fieldwork. Initially, the New Projects Unit attempted to collate all existing data of biological value in further bioreconnaissance and facility planning into 'backgrounder' reports. Only a few backgrounders were formally completed (Helm et al. MS1980a and MS1980b; MacDonald and Shepherd MS1983), due to a lack of manpower and to midstream switches in project priorities. Also this type of review activity is now requested as part of consultant biobaseline studies.

The majority of biobaseline studies were done through contracts with consultants, the B.C. Fish and Wildlife Branch, or through other job creation or education oriented programs through the Canada Employment and Immigration Commission (CEIC). There are definite drawbacks to this approach, such as the loss of in-house staff expertise in field work and local knowledge. Also, the government contracting-out process is lengthy, making it essential to establish an effective working relationship with the Department of Supply and Services (DSS). Steps were taken to streamline contracting procedures, such as standardization of contract specifications (Appendix B) and the use of word processors.

Depending on the situation, the field studies incorporated general biophysical reconnaissance for adult and juvenile phases, as well as site specific feasibility work. Appendix B gives a general outline of current program specifications.

Initially, much effort went into attempting to estimate juvenile and adult populations accurately, and to collect and rear fry for coded-wire tagging. These program components were expensive and often conflicted with other program objectives, such as definition of the distribution and duration of rearing. For the purposes of facility design, the start/peak/end dates of the wild fry migration are crucial; accurate enumeration of wild fry populations is needed only where facility fry may be outplanted for final rearing. Similarly, adult migration timing is critical; accurate numbers of spawners are less useful than knowing whether past estimates by Field Services can be used to project average availability of broodstock. Estuarine and freshwater rearing programs (eg. habitat carrying capacity) were emphasized as new knowledge of rearing and life history patterns became available. Coded-wire tagging of juveniles was of no direct use to facility design, but was included to provide information on stock contributions to fisheries. The first tag returns from wild stocks that had been pen-reared to taggable size were very poor, and management biologists requested that all such tagging programs be terminated. Elimination and adjustment of these items resulted in cost savings and allowed coverage of additional systems.

Further logistical and cost savings were made, both by consolidating neighbouring systems into study packages and by coordinating with other groups where possible. An example of the latter is the addition of an adult coho sampling component to a North Thompson juvenile tagging program undertaken for Field Services by a Job Creation crew (54).

Attempts were made to collect at least two years' adult and juvenile data, in order to allow some evaluation of variation between years.

Scale ageing was completed by the DFO Fish Morphology Laboratory in Vancouver. A modified Wild-Leitz projector magnified images (100x) from acetate scale impressions to a flat surface, to enable analysis of growth rings using a high-contrast light source. All growth characteristics were noted, including arrangements of circuli spacing and patterns, differences in circuli spacing, and differences in numbers of circuli or scale proportions. The basic methodology for ageing salmon scales is described in Clutter and Whitesel (1956) and for chinook salmon (Yole, DFO Vancouver, pers. comm.). Throughout this document, ages are recorded using the Gilbert-Rich formula (Koo 1962), where the total age is indicated first by a large number and the year in which the juvenile left freshwater is indicated by a subscript.

Disease analyses were conducted by the DFO Disease Diagnostics Service (DDS) at the Pacific Biological Station in Nanaimo. This unit carries out monitoring and surveillance of the health of both publicly and privately owned fish stocks, in addition to finding the cause and cure of disease outbreaks, developing and improving methods for the early detection of disease or disease agents, and conducting systematic mapping of disease distribution in wild populations.

Samples of live and moribund salmon from the study streams were examined on-site or were shipped freshly dead to DSS personnel. Field and laboratory analyses were consistent with Fish Health Protection Regulations (Canada Dept. Fish. Envir. 1977) and generally focussed on those infectious agents known to cause mortality among wild and cultured fishes. Analyses included:

- complete external and internal examination for gross signs of disease
- microscopic examination of gram stained smears of posterior kidney tissue
- aseptic streaking of kidney tissue onto petri plates containing tryptic soy agar for the detection of bacterial pathogens
- innoculation of two tissue culture cell lines (rainbow trout gonad and fathead minnow) with filtered homogenates of kidney tissue for the detection of viral agents
- histological sectioning of any tissues showing possible pathological evidence of disease
- intestinal smears stained with methylene blue for the detection of *Ceratomyxa shasta*.

ADULT DATA

SPAWNING POPULATIONS

In this group of reports, twenty-one separate field studies examined approximately sixty adult salmon populations, usually focussing on spawning numbers, timing and distribution of the target species selected for enhancement. In nearly all cases, estimating the number of spawners received the most technical attention, and timing and distribution data were less intensively addressed. In most cases, study timing and field logistics were based on Fishery Officers' local knowledge and historic stream file information on stock timings and distributions. These assumptions must be considered when reviewing the New Projects data on spawning populations.

In estimating salmon escapements, techniques used in the New Projects studies can be classified as visual ground level estimations (foot, boat, snorkel), air surveys (fixed wing, helicopter, air photography), counts past a given point (fishway, fence, tower) and mark recovery programs. To select the most appropriate methodology, project managers must correctly anticipate the number of fish, their watershed distribution, their timing of arrival and spawning and the species mix. Consequently, overall fish catchability, river size and configuration, weather, water and runoff conditions, watershed access and relative experience of the field personnel can affect success. The strengths and biases of each technique are described at length in Cousens et al. (1982) and in Ricker (1975). They are described here only where specific cases may have affected the data. In general, several methods were used for each New Projects study so that a best estimate could be made which considered the biases of the various techniques.

Timing

Timing estimates provided by Fishery Officers often are based on limited observations, especially in remote areas where multiple field excursions are impractical. Field trips undertaken by local Fishery Officers were generally planned for the dates when it was believed that immigration would be starting; spawning would be starting; spawning activity would be peaking; and/or spawning and die-off would be complete, or nearly so. This strategy can lead to peak timing being assumed rather than verified over the course of the season.

For target species, the New Projects data were more intensive than that provided by annual stream file reports. Timing data were obtained from a variety of techniques, primarily mark-recapture and streamside observation programs. Fence or fishway timing counts were the most accurate for determining the immigration timing of target species and since there were few estimators involved, population numbers could be deduced. This investment was made on single target stocks such as Finn chinook (36, 37), Salmon chinook (40, 41) Mussel chinook (60, 61) and Kakweiken pink (31, 32). In some cases such as Kemano chum studies (19, 20), timing received emphasis, because of environmental and fishery management issues that had to be considered in overall enhancement planning for that area.

For non-target species, timings were largely assumed and were seldom more accurate than existing information. Often New Projects and stream file information were in basic agreement but the New Projects start and end run timing dates were, respectively, earlier and later than those indicated in the stream files. The greatest drawback of the New Projects data was that project initiation and termination dates usually fell well within the boundaries of run timing, resulting in little new data on the initial immigration or final die-off periods.

Timing data estimates were divided into immigration, spawning and die-off phases and were recorded in Appendix C-1 (Volume II), extracted directly from the source documents. These data are compared in regional groupings (Figures 1 to 7).

Complex stock separation and migration timing patterns were often evident, especially in the Fraser River where 65 tributaries support chinook salmon and 150 support coho (Fraser et al, 1982). A longer freshwater migration subjects fish stocks to more stream variables (eg. flooding, temperature changes, obstructions) that may affect immigration timing, so that timing data must be defined as timing of migration past a certain point. The New Projects studies on the Fraser stocks referred to immigration into the spawning streams. Quesnel chinook peak spawning timing occurred 20 days earlier in 1980 than 1979, apparently as a result of sustained high discharges in 1980. In this case, spawning occurred in cooler water (11.5°C in 1980 vs 16°C in 1979) and for a longer duration (45 days in 1980 vs 30 day average from the stream file information). Note that sequential timing patterns in North and South Thompson tributaries (36, 37, 40, 41) may reflect the selection of study streams, the effects of rotating stream surveys on neighbouring systems, or some natural selective process.

Mechanisms that affect migration timing also occur in coastal areas. For example certain stocks in the central coast area, such as Kwatna pinks (60, 61), were subjected to target fisheries (Peacock et al. 1984). These may affect their immigration timing, although not usually spawning timing. Factors such as stream discharge, turbidity, temperature or obstructions may delay fish movements, making them more susceptible to commercial net fisheries (eg. Neekas chums, Peacock et al. 1986 in press). Fishing at a certain point in the run timing curve would then shift the immigration peak by removing individuals from that part of the run that would otherwise have created the peak. Major differences in chum timing between streams were evident in Knight Inlet in 1981 (30). Over the long term, spawning timing can change through genetic selection which presumably could occur through either planned or inadvertent processes.

Chinook (Figures 1, 2):

Chinook immigration and spawning timing in the upper Fraser

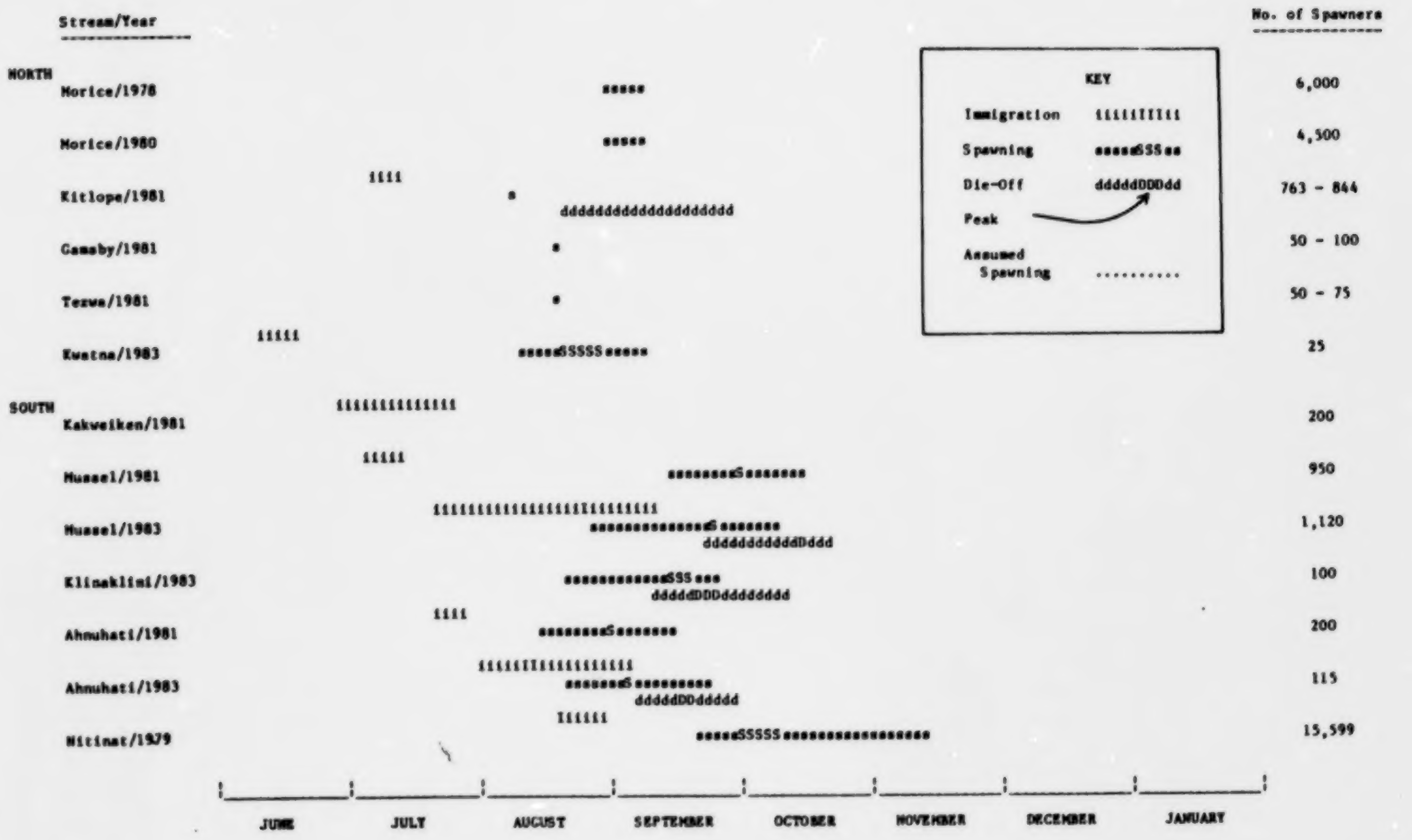

Figure 1. CHINOOK timing data obtained during New Projects studies on north and south coast streams.

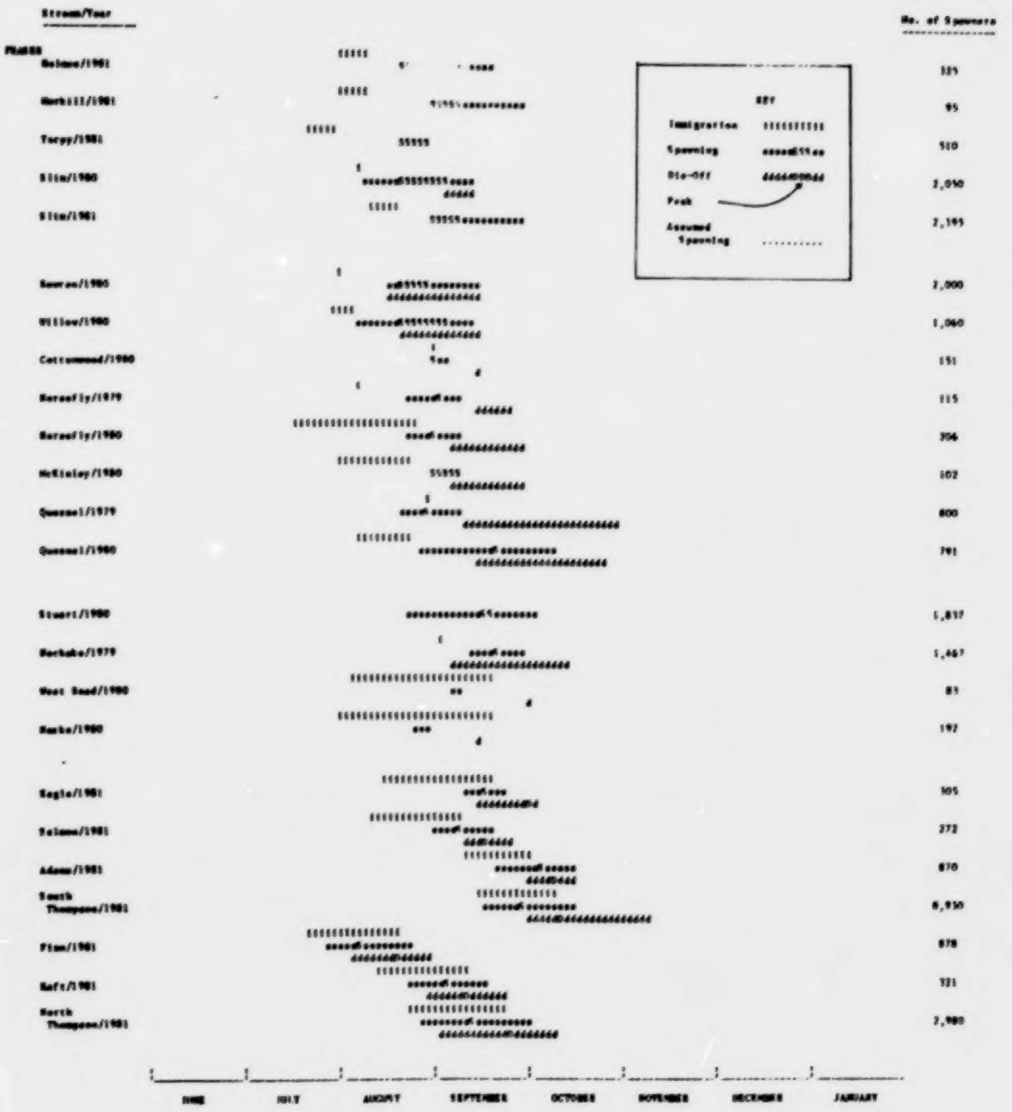

Figure 2. CHINOOK timing data obtained during New Projects studies on Fraser River tributary streams.

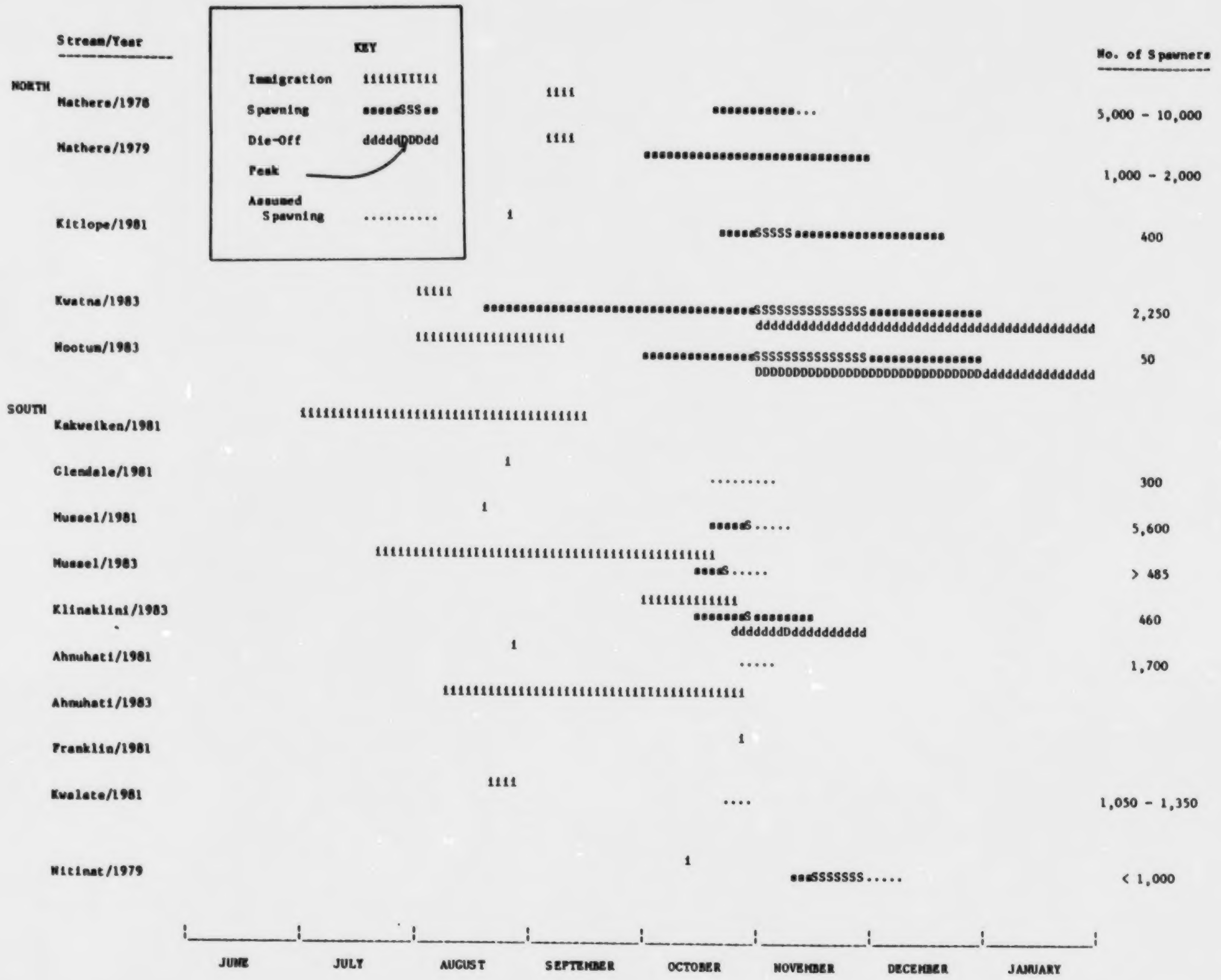

Figure 3. COHO timing data obtained during New Projects studies on north and south coast streams.

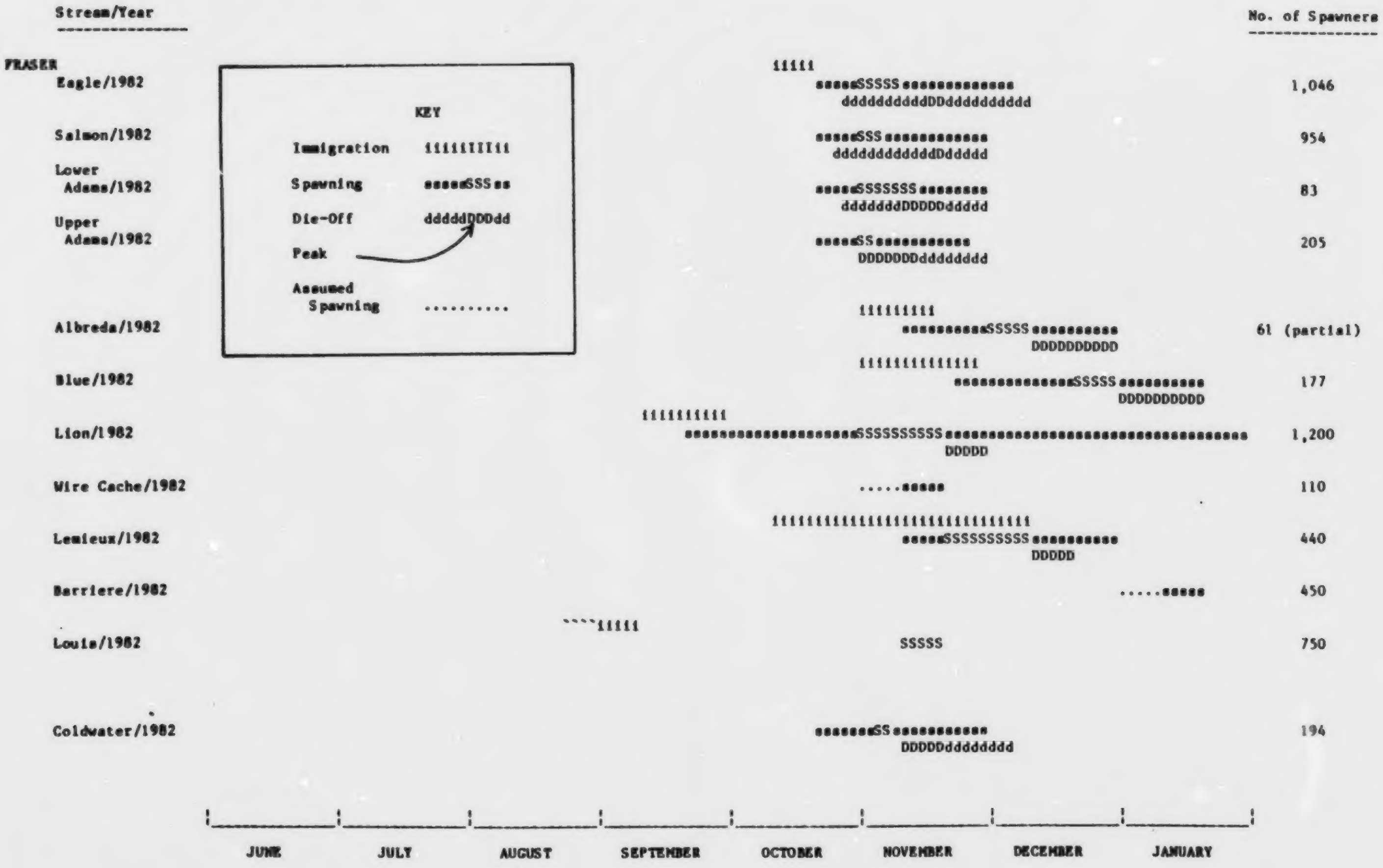

Figure 4. COHO timing data obtained during New Projects studies on Fraser River tributary streams.

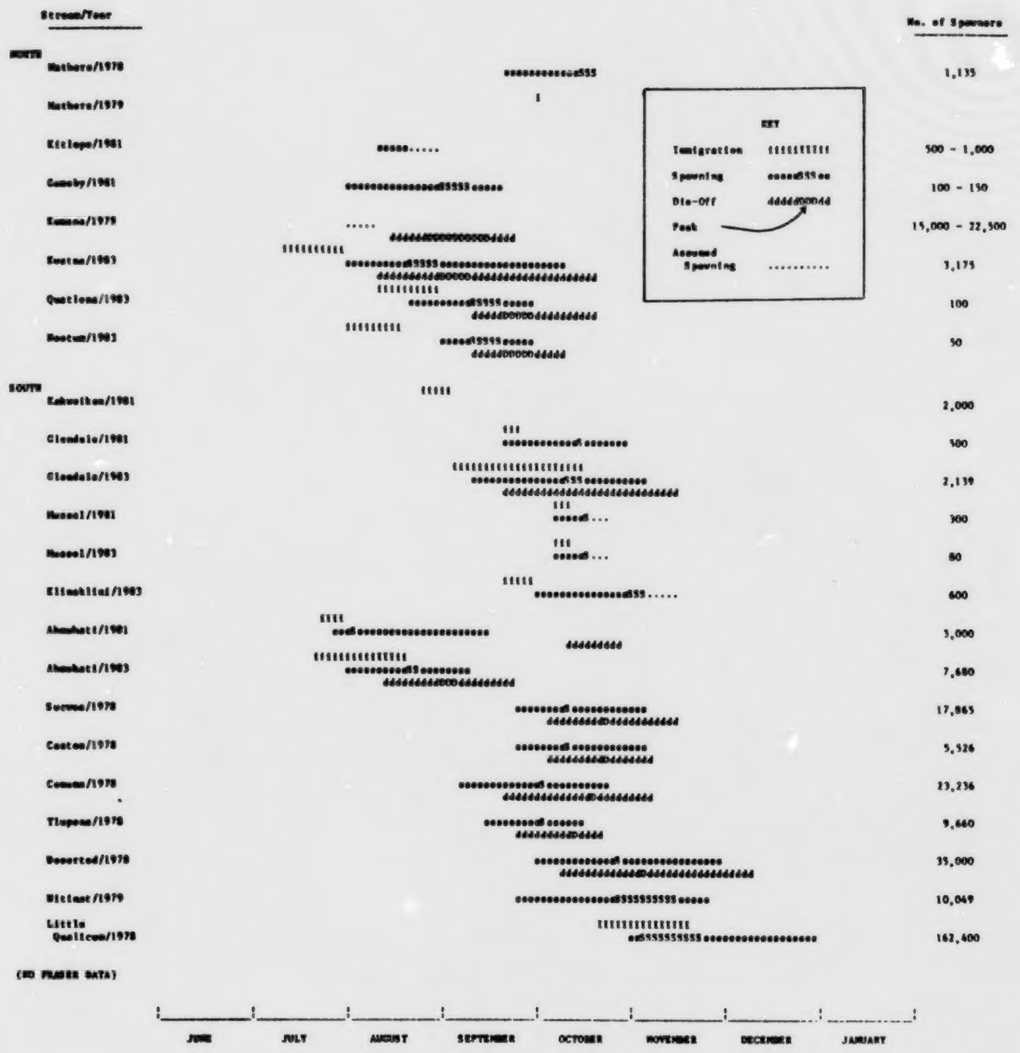

Figure 5. CHUM timing data obtained during New Projects studies.

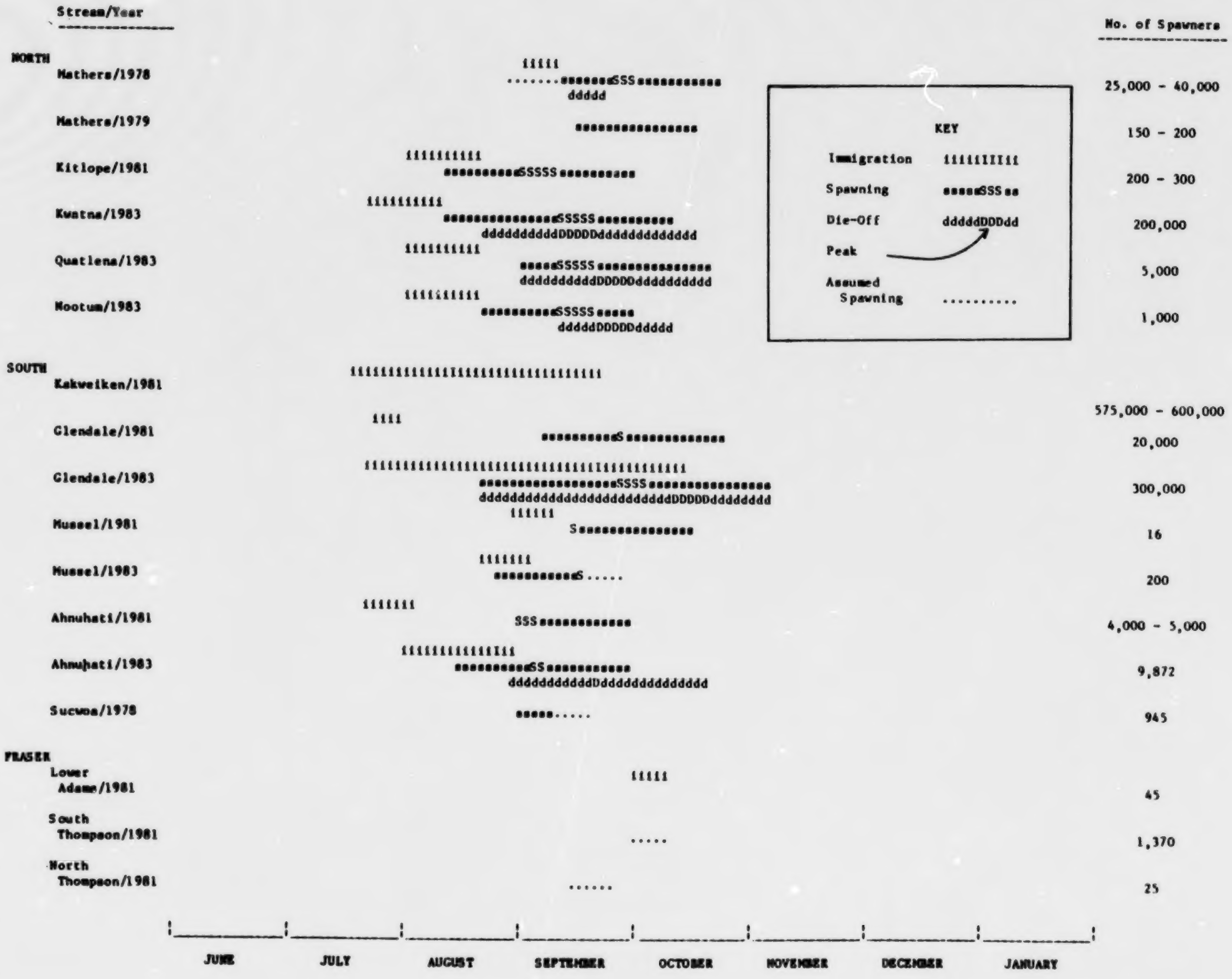

Figure 6. PINK timing data obtained during New Projects studies.

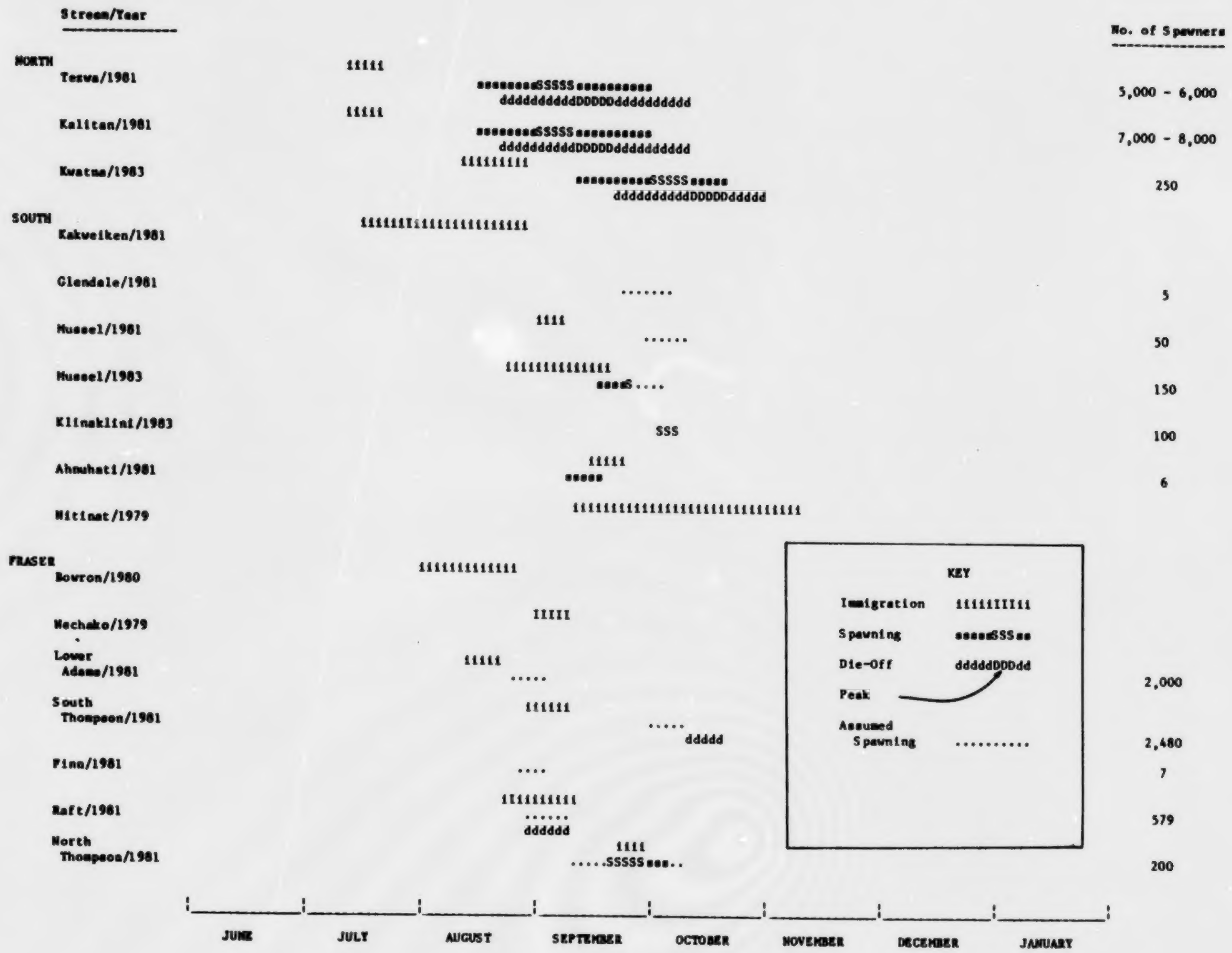

Figure 7. SOCKEYE timing data obtained during New Projects studies.

tributaries was not much different than chinook in the North and South Thompson tributaries (Figure 2). Fraser et al (1982) divided Fraser River chinook into early (upper Fraser), middle (North and South Thompson) and late (Harrison) migrating stocks, on the basis of timing through lower river fisheries; however, this split was not apparent further upstream. There appeared to be no difference in the time of chinook spawning between north and south coastal streams (August and September) although some differences existed between streams.

Coho (Figures 3, 4):

Very little information is available on complete coho runs, with the exception of North and South Thompson studies which were directed at that species (50, 51; 54). Thompson River coho timing was all late (Nov-Dec) compared to the South Coast (Oct-Nov) and North Coast (Nov). This timing may reflect those stocks chosen for study rather than the overall coho spawning timing in the Fraser River: Fraser et al. (1982) identified populations of Fraser River coho spawning from mid-October to as late as March.

Chum (Figure 5):

Chum salmon appeared to immigrate and spawn earlier in the north coast than in the south coast. There was an early-spawning summer chum run in the Ahnuhati River, similar to summer chum runs noted in other central coast areas (eg. Bella Coola; Hilland 1979). This agrees with the results from a central coast tagging program done in the late 1970s (Aquatic Resources Limited 1982) which indicated that outer Statistical Area 6 was an important migration path for chum salmon; northern-bound chum stocks were intercepted in early July whereas southern bound chum were caught later, from mid-July to mid-August.

Pink and Sockeye (Figures 6, 7):

There were not enough data gathered on these two species to generate any overall comparisons between regions, runs or years of study. One point of note was the prolonged pink spawning in the Glendale River (60, 61) due to high population numbers and limited spawning habitat availability. There was general agreement with stream file information.

Distribution

In order to estimate salmonid distribution within a watershed, all available data and local knowledge were gathered regarding locations of obstructions, known spawning areas and spawner timing. Field surveys, especially helicopter surveys, then were used to verify the accuracy of the information.

Appendix C-2 (Volume II) contains subjective notes on the habitat type, river location, and degree of concentration for actual and potential spawning and holding areas. The "methods" column refers to observation methods (eg. foot surveys) rather than the overall strategy used to determine fish distribution (eg. spawner day/turnover rate calculations for separate reaches). Distributions were usually illustrated on maps and for this reason are not reproduced here. Watershed-specific maps employed consistent reach designations from year to year, which allowed the identification of yearly changes in spawner distribution (see species writeups for details).

Fish density was often used to describe spawner distribution within a watercourse; however, spawner distributions can change as population numbers change. For example chum spawners in the Little Qualicum River were most abundant near the mouth, with upper river areas receiving variable numbers of spawners according to population pressure from downstream (1). Studies on chinook salmon in the Quesnel River (9, 18) noted considerable changes in spawner distribution between 1979 and 1980. Although the estimated escapement was similar for both years (800, 791 respectively) and apparently well below capacity, approximately 40% of the 1980 escapement spawned in areas not utilized in 1979. This was associated with changes in the discharge pattern and some associated habitat selectivity.

Some New Projects studies discovered new areas of fish distribution as well as new areas of apparently unutilized habitat. Until New Projects studies in the Quesnel system clearly identified the presence of coho salmon (8, 9, 16, 17, 18) no coho were recorded spawning or migrating upstream of the Thompson River confluence (Fraser et al. 1982). The Upper Klinaklini River was not examined in the normal course of fall spawner surveys, but was found to have good coho rearing potential above anadromous waters (60, 61). Coho studies in the North Thompson identified numerous unutilized spawning and rearing habitats in tributaries that were previously unrecorded (54).

Chinook:

Chinook were often found spawning at lake outlets, such as Morice (56, 57), Kitlope (46, 47), Quesnel (9, 18) and Adams (40, 41, 50, 51) Lakes and also in mainstem riffles such as the South Thompson (40, 41, 50, 51) and Nazko (18) Rivers. They are also noted to spawn in glide areas with fast water and coarse substrates (see SPAWNING HABITATS). They have been noted holding in deep mainstream pools and in generally larger systems, moving into tributaries to spawn (eg. Morkill, 42, 43). Chinook have been found to migrate far upstream, such as to the top of the Upper Fraser system.

Coho:

Coho were noted in small creeks but also in lake systems, often holding in lakes and moving upstream into tributaries to spawn (eg. Mathers, Glendale; 2, 7, 30, 60, 61). Larger tributaries in the Thompson contained both holding and spawning coho (eg. Adams, Albreda, Blue, Lion, Wire Cache; 40, 41, 50, 51, 36, 37, 54). They have also been found in the tributaries of larger river systems (eg. Nitinat, 10; Little Qualicum, 1) as well as utilizing sidechannel habitats (eg. above Mussel Lake 30, 60, 61). They generally are scattered in distribution and were often not clearly observed (eg. Kwatna, 64, 65) due to inclement weather corresponding to their generally late timing, and the inaccessibility of many of the streams.

Chum:

Chum characteristically were found in the lower reaches of systems, usually within a few kilometers of tidewater. Sidechannel spawning was noted (eg. Gamsby, Tsaytis, 46, 47; Quatlena 64, 65) as well as extensive tributary utilization (eg. Kwatna, 64, 65). Chum salmon may hold in either freshwater or estuarine environments, and some estuarine spawning has been observed (eg. Conuma, Deserted, 3; Kwatna, 64, 65), possibly related to local crowding (eg. Deserted, 3). There was an apparent attraction to clear-water or groundwater-fed areas.

Sockeye:

Sockeye spawning was noted in a wide variety of habitats (creek mouths, mainstems, lake outlets, lake tributaries). Major populations are usually associated with lake systems and have also been recorded spawning in glacial alluvium (eg. Kitlope, 46, 47). Sockeye juveniles have been found in systems without lakes (see JUVENILE REARING: Rearing Distribution). Small numbers of so-called "creek sockeye" were noted in several studies, such as at the mouth of a small tributary to the Conuma River (3). Some sockeye of uncertain origin were attracted to the Kemano River tailrace. As sockeye have been observed spawning in several rivers without lake systems they cannot be regarded as simply strays from other areas (see also Age).

Pink:

Several large pink populations were studied (eg. Kwatna, 64, 65; Kakweiken, 31, 32) and these were characterized by high-density holding and wave spawning, resulting in redd superimposition (eg. Oak-Beck Creek, 64, 65). There was also a population of pink salmon spawning in a tributary within tidal influence (eg. Kitlope, 46, 47) although it is unknown whether or not there was any intrusion of saltwater.

Abundance

Habitat protection concerns, management escapement counts, hatchery brood stock collection and other biological activities have relied primarily on subjective estimates of abundance and timing, provided through the DFO stream file system of annual spawner counts. The advantage of this method is that it provided an overview for all species, whereas biobaseline studies examined only a portion of the overall salmonid population in any intensity. With an overview such as that provided by the stream file system, it was possible to identify different groups of spawners that may have been isolated in timing or location. Subjective methods of estimating fish abundance were used exclusively in the Morice River (56) and Mathers Creek (7) biobaseline studies.

Mark-recapture methods, primarily the adjusted Peterson method (Ricker 1975), were used on large populations of chum salmon in the Little Qualicum and Nitinat Rivers (1, 10) as well as several Tlupana Inlet streams (3). Much smaller populations of chinook in the Quesnel, Blackwater and Cottonwood Rivers (18), Stuart River (15) and the North Thompson River and its tributaries (36, 37) were also tagged, although different capture and recovery methods were used. The adjusted Peterson technique can be corrected for tagging and recovery effort, and tag loss rates; abundance estimates can be made for male and female populations or on a time-phased basis given sufficient numbers of fish caught and recovered. In the Upper Fraser (42, 43), tagging was discontinued due to low numbers tagged. In the South Thompson (40, 41), low carcass recovery rates caused obvious overestimates. In the Kemano River (19, 20), spawning was well underway by the time fieldwork was initiated, so that initial mark-recovery plans were shelved.

Visual counts were also used for population estimation by graphing the numbers of live fish over time, establishing the area under the curve (spawner density) and dividing by the average number of days that spawners spend on the grounds (McNeil 1964). The latter "turnover rate" was estimated by either calculating the time difference between spawning and die-off cumulative percentiles (Neilson and Geen 1981), or by averaging the days to recovery as carcasses of tagged fish. The latter method was used on all of the Fraser River chinook and coho studies, usually in combination with other methods, as well as in the Knight Inlet and Burke Channel studies (30, 60, 61, 64, 65). Many of the studies applied both estimators, including the Stuart River studies (15), where there was major disagreement between the visual estimate of 590 chinook and the mark-recovery estimate of 1,837. In that case, the latter was considered the more accurate.

There were several different methods used to calculate turnover rate (Table 4). The time difference between tagging and carcass recovery of individual marked fish was used in several studies. Calculations were based on either the mean, median or modal time elapsed. It is possible that turnover rates were greater for fish tagged in estuaries (eg. Little Qualicum, 1) and less for fish tagged in stream sidechannels (eg. Kemano, 19, 20) as a result of differences in travel time from tidewater. Little Qualicum River studies (1) determined turnover rates for weekly time periods and suggested that for chum salmon, stream lifespan may be reduced near the end of the run:

Sex	Oct 24-30	Oct 31 -Nov 6	Nov 7-13	Nov 14-20	Nov 21-27	Nov 26 -Dec 4	Dec 5-14
Female	12	10	11	12	7	5	10
Male	UK	9	11	15	8	9	7

Lister and Harvey (1969) found that lifespan was highly dependent on the stage of the run for tagged Big Qualicum River chum spawners. Studies on Kemano chum populations (19, 20) found that although a 9-day residence time was observed early in the run, this dropped to a 4-day residence time

Table 4. Spawner turnover rates for salmon populations in New Projects Unit studies.

River, Year	Reference No.	Days between tagging and dead recovery of marked fish	Days between peak live and peak dead counts	Days between cumulative live and dead count percentiles
CHINOOK				
Stuart, 1980	15	7.3[a]	10.5	
Bowron, 1980	23,24			20.0[b]
Willow, 1980	23,24			19.0[b]
Wansa, 1980	23,24			18.0[b]
Slim, 1980	23,24			12.5
Finn, 1981	36,37	11.0[a]	11.0	
Raft, 1981	36,37	17.0[a]	15.0	
North Thompson, 1981	36,37		9.0	
Eagle, 1981	40,41		9.0	7.5
Salmon, 1981	40,41		11.0	7.7
Adams, 1981	40,41		8.0	9.1
South Thompson, 1981	40,41		7.0	10.7[c]
Slim, 1981	42,43		9.0 - 16.0	14.9[d]
Holmes, 1981	42,43		14.0	10.7[d]
Morkill, 1981	42,43		11.0	15.1[d]
Torpy, 1981	42,43		16.0	14.7[d]
Walker, 1981	42,43		13.0	6.9[d]
West Torpy, 1981	42,43		3.0 - 7.0	8.5[d]
Mussel, 1983	60,61		20.0[e]	
Ahnuhati, 1983	60,61		10.0[e]	
COHO				
Eagle, 1982	50,51		12.5	
Salmon, 1982	50,51		15.0	
Adams, 1982	50,51		10.0	
Coldwater, 1982	50,51		12.5	

/. . . continued

Table 4 (continued).

River, Year	Reference No.	Days between tagging and dead recovery of marked fish	Days between peak live and peak dead counts	Days between cumulative live and dead count percentiles
CHUM				
Little Qualicum, 1978	1	10.0[f]		
Sucwoa, 1978	3	8.2		
Canton, 1978	3	9.0		
Conuma, 1978	3	13.4		
Tlupana, 1978	3	9.4		
Deserted, 1978	3	9.5		
Kemano, 1979	19,20	9.0[g]		
Kemano, 1979	19,20	4.0[h]		
Ahnuhati, 1983	60,61		14.0[e]	
Glendale, 1983	60,61		12.0[e]	
PINK				
Ahnuhati, 1983	60,61		18.5	17.6
Glendale, 1983	60,61		15.0	24.0[i]
MEAN TURNOVER RATES				
Chinook		11.8	10.9	12.5
Coho			12.5	
Chum		9.1	13.0	
Pink		16.8	20.8	

[a] Median days out to recovery of tagged fish.

[b] Underestimated maximum live counts due to turbid water; residence time may be overestimated.

[c] Die-off curve reflects sampling effort rather than actual die-off due to large numbers of carcasses.

[d] Arrival time extrapolated assuming normal curves.

[e] Substantial bear predation; relatively low numbers of carcasses recovered.

[f] Stream lifespan determined by modal number of days out to tag recovery, adjusted down by four days.

[g] Early in run.

[h] Late in run.

[i] Very large escapement and limited habitat forced population into extended holding.

in the latter part of the run. Secondly, the number of days between the peak live and peak dead counts were calculated. This method was most useful for streams that had relatively small escapements and in cases where the timing peaks were well-defined (eg. Knight Inlet, 60, 61 and South Thompson, 42, 43). Problems with this method arose when there were protracted spawning peaks (eg. South Thompson, 42, 43) or when the timing or magnitude of maximum counts were unclear (eg. due to turbid water, flooding or irregular surveys). Finally, the live and dead counts were broken into percentiles and the average number of days was calculated. This method was most effective when used to determine turnover rates for relatively large populations with extended spawning and die-off periods (eg. Glendale, 60, 61).

Most often, subjective visual surveys (aircraft, foot, boat, divers) were combined with a tag-recovery program. Another method used on large systems involved carcass counts (eg. Kemano, 19, 20) adjusted using carcass recovery rates determined from other studies. Most of the studies applied several abundance estimates and then selected a best estimate based on the perceived suitability of the system/stock to the various methods.

Some abundance estimates were better than others. Stream file and biobaseline study data are compared in Tables 5 to 9 (also Appendix C-3, Volume II). Where the consultant provided two or more estimates as a result of using several field techniques, the estimate in which the consultant showed the most confidence was chosen. Target and non-target stocks were distinguished for the New Projects studies, in order to identify those species that were likely to have had the best study timing. This is probably also a factor in the D.F.O. stream files but a similar breakout was not available.

In general, the New Projects study estimates were greater than the annual stream file estimates. Considering only the target stocks listed in Tables 5 - 9 and averaging these, there were some large overall differences by species:

Species	% of the Stream File Estimate
Chinook	141 %
Coho	128 %
Pink	99 %
Chum	216 % (including Little Qualicum)
Sockeye	Not determined

Table 5. Summary table for CHINOOK salmon abundance estimates, comparing data obtained during New Projects studies (NP) with DFO stream file records (SF) for the same year.

Region	Stream	Year	NP Estimate	SF Estimate
NORTH	Morice	1978	6,000 *	6,000
	Morice	1979	4,100 *	no report
	Morice	1980	4,500 *	4,500
	Kitlope	1981	763 - 844 *	800
	Gamsby	1981	50 - 100 *	(incl. in Kitlope)
	Tezwa	1981	50 - 75 *	(incl. in Kitlope)
	Kalitan	1981	< 25 *	(incl. in Kitlope)
	Kowesas	1981	50 - 100 *	60
	Tsaytis	1981	< 20 *	20
	Kemano	1979	1,000	1,000
	Kwatna	1983	50	50
SOUTH	Kakweiken	1981	18 *	200
	Glendale	1983	2 *	2
	Mussel	1981	950 *	1,000
	Mussel	1983	1,120 *	(incl. in Klinaklini)
	Klinaklini	1983	100 *	1,200
	Ahnuhati	1981	200 *	not observed
	Ahnuhati	1983	115 *	not observed
	Sucwoa	1978	981	not observed
	Canton	1978	500 - 600	not observed
	Conuma	1978	300 - 500	500
	Tlupana	1978	7	not recorded
	Deserted	1978	827	200
	Nitinat	1979	15,599	3,500
	L. Qualicum	1978	10	30
FRASER	Holmes	1981	325 *	400
	Morkill	1981	95 *	150
	Torpy	1981	510 *	540
	W. Torpy	1981	150 *	(incl. in Torpy)
	Walker	1981	480 *	140
	Slim	1980	2,050 *	1,455
	Slim	1981	2,395 *	1,335
	Bowron	1980	2,000 *	1,300
	Willow	1980	1,060 *	150
	Stuart	1980	1,837 *	426
	Nechako	1979	1,467 *	1,800
	West Road	1980	83 *	900
	Baezaeko	1980	87 *	(incl. in West Road)

/. . . continued

Table 5 (continued).

Region	Stream	Year	NP Estimate	SF Estimate
FRASER (cont'd)	Clisbako	1980	1 *	(incl. in West Road)
	Nazko	1980	192 *	(incl. in West Road)
	Cottonwood	1980	151 *	300
	Mitchell	1980	1 *	not recorded
	Horsefly	1979	115 *	350
	Horsefly	1980	206 *	250
	McKinley	1980	102 *	(incl. in Horsefly)
	Cariboo	1980	35 *	(incl. in Horsefly)
	Quesnel	1979	800 *	900
	Quesnel	1980	791 *	950
	Eagle	1981	305 *	300
	Salmon	1981	272 *	300
	L. Adams	1981	870 *	750
	S. Thompson	1981	8,930 *	6,000
	Finn	1981	878 *	1,000
	Raft	1981	321 *	200
	N. Thompson	1981	2,980 *	unknown

* Target species (see Tables 1 - 3).

Table 6. Summary table for COHO salmon abundance estimates, comparing data obtained during New Projects studies (NP) with DFO stream file records (SF) for the same year.

Region	Stream	Year	NP Estimate	SF Estimate
NORTH	Mathers	1978	5,000 - 10,000	10,000
	Mathers	1979	1,000 - 2,000	unknown
	Kitlope	1981	400 *	2,000
	Gamsby	1981	7,325 *	(included in Kitlope)
	Tezwa	1981	50 - 75 *	(included in Kitlope)
	Kalitan	1981	1,000 *	(included in Kitlope)
	Kowesas	1981	1,350 *	not observed
	Tsaytis	1981	4,000 *	not observed
	Kemano	1979	39	3,000
	Kwatna	1983	2,250 *	3,500
	Nootum	1983	50 *	25
SOUTH	Kakweiken	1981	2,418 *	7,000
	Glendale	1981	300 *	300
	Glendale	1983	1 *	2,400
	Mussel	1981	5,600 *	500
	Mussel	1983	> 485 *	(included in Klinaklini)
	Klinaklini	1983	460 *	950
	Ahnuhati	1981	1,700 *	2,100
	Ahnuhati	1983	1,010 *	1,000
	Franklin	1981	1 *	2,400
	Kwalate	1981	1,050 - 1,350 *	300
	Sucwoa	1978	130	no report
	Canton	1978	200 - 300	none observed
	Conuma	1978	800 - 1,000	400
	Tlupana	1978	800 - 1,000	300
	Deserted	1978	50 - 100	none observed
	Nitinat	1979	< 1,000	600
	L. Qualicum	1978	455	5,500
FRASER	Eagle	1982	1,046 *	1,000
	Salmon	1982	954 *	800
	L. Adams	1981	22	100
	L. Adams	1982	83 *	100
	U. Adams	1982	205 *	200
	S. Thompson	1981	1	no report
	Albreda	1982	61 *	550
	Blue	1982	177 *	450
	Lion	1982	1,200 *	1,200
	Wire Cache	1982	110 *	110

* Target species (see Tables 1 - 3).

Table 7. Summary table for CHUM salmon abundance estimates, comparing data obtained during New Projects studies (NP) with DFO stream file records (SF) for the same year.

Region	Stream	Year	NP Estimate	SF Estimate
NORTH	Mathers	1978	1,135 *	1,000
	Mathers	1979	50 - 75 *	75
	Kitlope	1981	500 - 1,000 *	1,000
	Gamsby	1981	100 - 500 *	(incl. in Kitlope)
	Kowesas	1981	< 50 *	25
	Tsaytis	1981	100 *	50
	Kwatna	1983	3,175 *	5,500
	Quatlena	1983	100 *	40
	Nootum	1983	50 *	200
	Kemano	1979	15,000 - 22,500 *	20,000
SOUTH	Kakweiken	1981	2,000 *	300 - 500
	Glendale	1981	500 *	300
	Glendale	1983	2,139 *	2,100
	Mussel	1981	300 *	300
	Mussel	1983	80 *	unknown
	Klinaklini	1983	600 *	700
	Ahnuhati	1981	3,000 *	3,000
	Ahnuhati	1983	7,680 *	6,400
	Kwalate	1981	200 *	200
	Sucwoa	1978	17,865 *	no record
	Canton	1978	5,526 *	800
	Conuma	1978	23,236 *	7,500
	Tlupana	1978	9,660 *	3,500
	Deserted	1978	35,000 *	9,000
	Nitinat	1979	10,049 *	4,000
	L. Qualicum	1978	162,400 *	75,000

* Target species (see Tables 1 - 3).

Table 8. Summary table for PINK salmon abundance estimates, comparing data obtained during New Projects studies (NP) with DFO stream file records (SF) for the same year.

Region	Stream	Year	NP Estimate	SF Estimate
NORTH	Mathers	1978	25,000 - 40,000	50,000
	Mathers	1979	150 - 200	none recorded
	Kitlope	1981	200 - 300 *	100
	Kemano	1979	15,000 - 20,000	40,000
	Kwatna	1983	200,000 *	200,000
	Quatlena	1983	5,000 *	4,000
SOUTH	Kakweiken	1981	575,000 - 600,000 *	600,000
	Glendale	1981	20,000 *	20,000
	Glendale	1983	300,000 *	300,000
	Mussel	1981	16 *	(incl. in Klinaklini)
	Mussel	1983	200 *	(incl. in Klinaklini)
	Klinaklini	1983	25 *	225
	Ahnuhati	1981	4,000 - 5,000 *	7,000
	Ahnuhati	1983	9,872 *	9,000
	Kwalate	1981	750 - 1,000 *	1,000
	Sucwoa	1978	945	none recorded
	Canton	1978	100	none observed
	Conuma	1978	< 1,000	1,000
	Tlupana	1978	present	100
	Deserted	1978	< 100	50
FRASER	L. Adams	1981	45	1,100
	S. Thompson	1981	1,370	1,560
	N. Thompson	1981	25	20

* Target species (see Tables 1 to 3).

Table 9. Summary table for SOCKEYE salmon abundance estimates, comparing data obtained during New Projects studies (NP) with DFO stream file records (SF) for the same year.

Region	Stream	Year	NP Estimate	SF Estimate
NORTH	Kitlope L.	1981	400 - 500 *	(incl. in Kitlope)
	Tezwa	1981	5,000 - 6,000 *	(incl. in Kitlope)
	Kalitan	1981	7,000 - 8,000 *	(incl. in Kitlope)
	Kowesas	1981	10 *	none observed
	Kemano	1979	2	25
	Kwatna	1983	250	100
	Kitlope	1981	0 *	none recorded
SOUTH	Kakweiken	1981	500 *	300 - 500
	Glendale	1981	5 *	none observed
	Glendale	1983	6 *	6
	Mussel	1981	50 *	(incl. in Klinaklini)
	Mussel	1983	150 *	(incl. in Klinaklini)
	Klinaklini	1983	100 *	220
	Ahnuhati	1981	6 *	none recorded
	Ahnuhati	1983	10 *	10
	Sucwoa	1978	323	none recorded
	Canton	1978	50 - 100	75
	Conuma	1978	100	400
	Tlupana	1978	present	none recorded
	Deserted	1978	< 100	10
	Nitinat	1979	6	80
	L. Qualicum	1978	24	45
FRASER	Bowron	1980	present	3,500
	Nechako	1979	40	none recorded
	Mitchell	1980	8	none observed
	Horsefly	1979	present	400
	Horsefly	1980	175	150
	McKinley	1980	85	(incl. in Horsefly)
	Quesnel	1980	20	none recorded
	L. Adams	1981	2,000	31,000
	S. Thompson	1981	2,480	200
	Finn	1981	7	8
	Raft	1981	579	600
	N. Thompson	1981	200	600

*Target species (see Tables 1 - 3). Sockeye data were primarily collected incidentally to other species for various coastal inlets.

There could be several reasons for these differences. For some chinook and coho stocks, there appeared to be a consistent under-reporting. For larger stocks of chum and pink, there was considerable disagreement surrounding abundance estimates of certain large populations, although others were in accord where they were based on the same field information. Species-by-species differences are discussed below.

Chinook (Table 5):

There appeared to be consistent under-reporting of individual stocks in all areas. In the Fraser River, improved watershed access and survey techniques as well as an increasing knowledge of individual stocks may have masked an overall stock decline through the addition of new streams to the stream file survey list and by recording fish spawning in more remote areas (Fraser et al. 1982). This theory could be extended to the central coast and west coast of Vancouver Island, where several stocks were "not observed" until the New Projects studies.

In a comparison of accuracy of various methods of monitoring salmon escapement, only 4% to 50% of the chinook actually counted at a fence were counted visually in several Pacific streams (Symons and Waldichuk. 1984). Although chinook salmon were often a target species for the New Projects studies, the method most often selected as the best estimate was a visual one.

Coho (Table 6):

Coho were considerably under-reported only in the north, where there was a discrepancy of about 16,000 spawners in the Gardner Canal area and several major streams were "not observed" in the stream file system. In this case, the Fishery Officers were considered to be underestimating coho stocks as their surveys did not extend into October and November, when coho would be expected (64, 65).

Similar to chinook, most of the best estimates were made from various visual methods (foot, boat, air surveys; spawner-day turnover methods). Given that this species is widely-dispersed in many small tributary populations, it is difficult to effectively estimate system escapements. Also similar to chinook, the number of fish recorded visually was far below fence counts on the same population. Of fish already enumerated past the Big Qualicum River fence, observers walking on the streamside reported 1.5%, observers rafting or floating reported 25% and observers swimming in the river reported 65% of the actual number present (T. Shardlow, DFO Nanaimo, pers. comm.). New Projects coho population estimates were probably similarly under-reported, since rarely were non-visual methods applied for comparison.

Chum (Table 7):

There was considerable disagreement surrounding some large chum populations in the south coast, especially in the Little Qualicum (1) but also in Tlupana Inlet streams (3) and in the Nitinat area (10). All of these studies relied on tag-recovery information for the final population estimate, and applied various correction factors. Tag-recovery estimates were considered preferable to visual estimates as they could more accurately assess large schools of fish holding in certain areas, or large numbers of fish moving within the system. In the assessment of mark-recapture estimates of salmon escapements of a known size (Simpson, in Symons and Waldichuk 1984), considerable overestimates were made for sockeye and pink populations (from +21% to +45% error relative to the fence counts). A much smaller level of disagreement was found for chum salmon (4%) based on limited data. It is possible that when the consultants had to choose between disagreeing abundance estimates on very large populations, the "best" estimate was also an overestimate.

Pink (Table 8):

There were a few very large pink salmon stocks that received a great deal of abundance-estimation effort in the New Projects studies, particularly the Kwatna (64, 65), Kakweiken (31, 32) and Glendale (30, 61, 62) Rivers. These systems normally receive special emphasis on an annual basis and in order to avoid duplication of effort the New Projects estimates became part of the stream file information.

Note that only in the Kakweiken study, where fishway counts were made, were visual techniques not used to estimate population abundance. The Kwatna pink population was estimated from visual surveys and a carcass recovery program; the Glendale/Tom Brown system estimates were entirely visual in both years of study.

Sockeye (Table 9):

Sockeye were never the target stock -- data for the populations listed in Table 9 were primarily collected incidentally for various coastal inlets (eg. Burke, Gardner, Tlupana, Knight) described in SCOPE OF THE STUDIES. Since the development emphasis was on other species with concern for sockeye as an intercepted stock, the populations were mostly small and a quantitative comparison of the New Projects and stream file estimates was not made. Several large sockeye stocks dominate coastal fisheries and most of the populations represented here were insignificant to those fisheries.

SPAWNER CHARACTERISTICS

Biological data on the characteristics of spawning salmon populations were collected to provide standards that could be incorporated into enhancement facility design. In particular, statistics on brood stock availability and age structure were used to develop the expected rate of fish production. Sex ratio and fecundity estimates, as well as estimates of egg diameter and egg retention, are useful in projecting broodstock requirements. Age composition is used in production forecasting and together with broodstock availability are important factors when examining economic impacts and project financing. Length data were used to estimate average fecundity for a population from the few fecundity samples normally available (limited in order to conserve wild populations). Aside from its economic impact on catch values, flesh colour in chinook salmon has been seen as a racial characteristic that can aid in fishery management and may have to be considered in developing a long-term genetic strategy for a hatchery.

Sex Ratio

In most cases the consultants were asked to assess the female:male (F:M) ratio, although this factor was generally assumed to be 1:1 for most of the New Projects studies. In some cases, such as the Little Qualicum chum study (1) and the South Thompson chinook and coho study (40, 41) tagging was used to estimate male and female populations separately, thus arriving at population and egg deposition estimates and sex ratios by corollary. Other studies conducted sex ratio sampling using timing and gear types that they felt were effectively sampling both sexes, while others derived sex ratio estimates from fence or fishway counts that relied less on overall population sampling.

The sex ratios detailed in Appendix C-4 (Volume II) have been standardized from the source reports so that jacks are included in the

Table 10. Sex ratios (number of females for each male) of salmon populations sampled during New Projects Studies, all gear types combined.

Stream	Year	Chinook	Coho	Chum	Sockeye	Pink
NORTH						
Mathers	1978	-----	0.39	0.92[a]	-----	-----
Mathers	1979	-----	0.67[b]	0.43[b]	-----	-----
Kemano	1979	1.21	1.17[b]	1.39[a]	-----	2.19[a]
Gamsby	1981	-----	-----	1.11[b]	-----	-----
Tezwa	1981	-----	-----	-----	0.43[b]	-----
Kalitan	1981	-----	-----	-----	0.30[a]	-----
Kitlope	1981	0.98	-----	0.61	1.27[b]	1.00[b]
Kwatna	1983	-----	0.60[d]	0.80[a]	0.57[b]	1.30[a]
Quatlena	1983	-----	-----	0.80	-----	1.10[a]
Morice	1978	0.84	-----	-----	-----	-----
Morice	1979	0.97[a]	-----	-----	-----	1.61
Morice	1980	2.09[a]	-----	-----	-----	-----
SOUTH						
Kakweiken	1981	-----	0.85[a]	0.70	0.67	0.82[a]
Glendale, Tom Browne	1981	-----	-----	1.67[b]	-----	0.59[b]
Glendale, Tom Browne	1983	-----	-----	0.67[b]	-----	1.04[a]
Mussel	1981	0.52[b]	-----	-----	-----	-----
Mussel	1983	1.11[a]	0.43	0.17[b]	0.14[b]	0.17[b]
Klinaklini	1983	1.50[b]	0.30[b]	-----	-----	1.38[b]
Ahnuhati	1981	-----	-----	1.44[b]	-----	-----
Ahnuhati	1983	1.09[b]	0.17[b]	0.73	-----	1.38[a]
Sucwoa	1978	0.50[a]	0.62[b]	1.30	0.97	1.99[a]
Canton	1978	0.08[b]	0.80[b]	1.42[a]	1.44[b]	1.33[b]
Conuma	1978	0.65	1.03	1.24[a]	0.70	3.26
Tlupana	1978	0.75[b]	-----	1.29[a]	-----	-----
Deserted	1978	0.65	1.00[b]	1.24[a]	-----	0.14[b]
Nitinat	1979	0.95[a]	1.75[b]	1.14[a]	-----	-----
Little Qualicum	1978	0.80[b]	0.70	1.24[a]	-----	-----
FRASER						
Holmes	1981	2.00[b]	-----	-----	-----	-----
Torpy	1981	1.53[b]	-----	-----	-----	-----
West Torpy	1981	1.43[b]	-----	-----	-----	-----

/. . . continued

Table 10 (continued).

Stream	Year	Chinook	Coho	Chum	Sockeye	Pink
FRASER (continued)						
Walker	1981	1.03	-----	-----	-----	-----
Slim	1980	2.74	-----	-----	-----	-----
Slim	1981	1.21[a]	-----	-----	-----	-----
Bowron	1980	2.22	-----	-----	-----	-----
Willow	1980	2.50	-----	-----	-----	-----
Wansa	1980	8.00[b]	-----	-----	-----	-----
Stuart	1980	1.52[a]	-----	-----	-----	-----
Nechako	1979	1.10[b]	-----	-----	-----	-----
Westroad	1980	0.40[b]	-----	-----	-----	-----
Nazko	1980	0.67[b]	-----	-----	-----	-----
Cottonwood	1980	1.75[b]	-----	-----	-----	-----
McKinley	1980	0.58[b]	-----	-----	-----	-----
Horsefly	1979	1.71	-----	-----	-----	-----
Horsefly	1980	1.18	-----	-----	-----	-----
Quesnel	1979	0.82	-----	-----	-----	-----
Quesnel	1980	1.18[a]	-----	-----	-----	-----
Eagle	1981	1.23	-----	-----	-----	-----
Eagle	1982	-----	1.64[a]	-----	-----	-----
Salmon	1981	1.72	-----	-----	-----	-----
Salmon	1982	-----	0.66	-----	-----	-----
South Thompson	1981	4.88[a]	-----	-----	-----	-----
Lower Adams	1981	1.84	-----	-----	-----	-----
Lower Adams	1982	-----	0.92[b]	-----	-----	-----
Upper Adams	1982	-----	0.90[b]	-----	-----	-----
Finn	1981	0.87[a]	-----	-----	-----	-----
Raft	1981	0.59[a]	-----	-----	-----	-----
North Thompson	1981	0.98[a]	-----	-----	-----	-----
Albreda	1982	-----	1.13[b]	-----	-----	-----
Lion	1982	-----	1.87[a]	-----	-----	-----
Wire Cache	1982	-----	1.19	-----	-----	-----
Lemeiux	1982	-----	1.65	-----	-----	-----
Barriere	1982	-----	3.25	-----	-----	-----
Louis, Christian	1982	-----	0.98[a]	-----	-----	-----
Coldwater	1982	-----	0.82[b]	-----	-----	-----

[a] N > 200

[b] N < 50

overall sex ratios given. In cases where more than one gear type was used to obtain samples, an overall average was derived (Table 10).

Sex ratios probably are often significantly biased due to sex-linked behaviour patterns which are not well documented and possibly vary between populations. Differing times of stream entry and die-off for females and males (eg. Mussel Cr. chinook; 60, 61) may be responsible for considerable error in those studies not encompassing the full run timing or relying on low sample sizes. There also appears to be some degree of gear or sampling selectivity: carcass sampling results in significantly higher female proportions for chinook, coho and chum (Table 11). This may be due to females remaining near their redds until moribund and thus being less likely to be washed downstream compared to the wider-ranging males. In cases where predation was heavy, the sex ratio has been suggested to be skewed in the opposite direction for the same reason. Seining often resulted in higher proportions of males, as they seem to be prone to capture due to their more exaggerated secondary sexual characteristics such as teeth and humps. It has been suggested that there were sex-specific differences in response to bait during angling, in that females were captured more often (40, 41).

It is evident that not all salmonid populations can be presumed to be 1:1 in their sex ratio. Despite indications of unequal F:M proportions in the populations, a F:M ratio of 1:1 was often assumed by consultants in order to estimate egg deposition (compare information from Appendix C-4 (Volume II) and Table 10). For example, more than 800 chinook carcasses were sampled in the South Thompson River in 1981, which represented 9% of the escapement and reflected a female population five times the size of the male population (40, 41). The study subsequently used a 1:1 sex ratio for estimating egg deposition and assumed that sampling was biased due to extensive carcass recoveries. Over 200 coho carcasses were recovered in the Eagle River in 1982, representing 20% of the escapement and a female proportion of about 1.7 (50, 51). This estimate was considered accurate as it agreed with the live sampling sex ratio of 1.8 females per male.

Age

Over the seven-year period of these studies, about 10,000 adult salmon were sampled and about 50,000 scales were read. Some otoliths were taken from chinook in Upper Fraser River tributaries (42, 43) and from sockeye in Gardner Canal (46, 47) but were not read in time for inclusion in the source report.

Table 11. Comparison of gear selectivity in determining sex ratios.

	Proportion Female Chinook	 Coho	 Chum
Carcass Sampling			
Number of Streams	8	14	12
Mean Female Proportion	2.42	1.41	1.19
S.D.	1.62	0.74	0.27
Angling Samples			
Number of Streams	8	9	0
Mean Female Proportion	0.92	0.68	-
S.D.	0.28	0.41	-
Seining Samples			
Number of Streams	-	-	8
Mean Female Proportion	-	-	0.76
S.D.	-	-	0.25
Probability (t-test for independant samples)	.0211	.0129	.002

Age composition data were presented inconsistently between studies and required extensive recalculation in order to employ a standard format. In general, most studies did not break down the data sufficiently in terms of age group or sex, so source report appendices were used as the primary data source. Some length and age data were rejected if badly decomposed fish were measured, or if obvious data flaws existed (eg. switched postorbital-hypural and fork length data). Regeneration rates were identified within each population studied in order to clarify whether or not scales from fish taken far from tidewater could be compensated for by taking more scales per fish. Age composition data are presented in percent for each age-class, with regenerated scales excluded from the breakdown. Note that the total number of fish sampled (n) includes regenerated scales so that the total number of readable scales used to derive the age breakdown is N - R. The reworked results were compiled in Appendices C-5 and C-6 (age and length at age, respectively; Volume II).

Appendices in the source reports were considered to be the primary reference and were used as a basis for calculations. In all cases, individual scale age determinations made by the DFO scale laboratory were considered to be correct. Laboratory records on population age determinations were also frequently referred to in the course of this study: in cases where the scale laboratory's population data disagreed with that obtained by the consultant's, the latter were considered to be correct.

The size of this body of age data is such that it has been summarized in three ways. Appendix C-5 (Volume II) contains age composition breakdowns on a stream-by-stream basis, in percentiles for each age as well as total numbers of scales read and regenerated. Tables 12 to 15 contain a tabular summary of these data, grouped regionally. Figures 8 to 11 depict the same regionally averaged data graphically. Regional age proportions were calculated so that the percentage of a given age group carried equal weight for each stream, regardless of the number of fish sampled in that stream. While each age component in the individual studies was not equally reliable, due to sex-related age and behavioural differences as well as annual fluctuations in age pattern, using this method avoids skewing the results in favour of large spawning populations which have been intensively sampled. Some studies which had very low sample sizes (eg, Little Qualicum River chinook where only nine fish were sampled; 1).

The New Projects field studies employed a variety of methods to obtain fish for sampling. In most cases, temporally and spatially representative sampling was done for the target or dominant species, but sampling was only opportunistic for incidental species. As previously discussed, the

Table 12. Regional summary of CHINOOK age composition results from salmon stocks sampled during New Projects studies.

Area	Total Sample Size	No. of Streams	Sex	Percentage at Age												Not[a] Readable
				2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	
NORTH TOTAL	91		M	1.1	0	12.8	2.7	3.9	38.3	3.6	23.7	0	0	13.8	0.2	10.2
	394		F	0	0	0.1	0.1	5.3	2.3	37.4	37.8	0	0	16.7	0.3	7.4
	685	3	T	0.4	0	5.5	1.5	5.2	19.4	23.3	29.7	0	0	14.8	0.3	8.4
Knight Inlet	129		M	0.3	0	0.6	25.1	7.0	26.8	0.3	28.8	5.6	0	0	5.6	28.9
	129		F	0	0	0	0	0.8	1.4	8.1	55.2	0	1.4	33.1	0	17.3
	258	2	T	0.2	0	0.3	11.4	3.8	13.3	4.5	43.0	2.7	0.7	17.6	2.7	24.6
West Coast Vancouver Is.	147		M	37.7	0	36.1	0	14.3	3.1	8.8	0	0	0	0	0	NG[b]
	117		F	5.1	0	2.6	0.7	56.3	0	35.3	0	0	0	0	0	NG
	264	4	T	27.9	0	30.2	0.3	23.1	2.4	16.1	0	0	0	0	0	NG
East Coast Vancouver Is.	5		M	40.0	0	40.0	0	20.0	0	0	0	0	0	0	0	0
	4		F	0	0	0	0	100.0	0	0	0	0	0	0	0	25.0
	9	1	T	25.0	0	25.0	0	50.0	0	0	0	0	0	0	0	11.1
SOUTH TOTAL	281		M	19.0	0	18.4	12.6	10.7	15.0	4.6	14.4	2.8	0	0	2.8	28.9
	246		F	2.6	0	1.3	0.4	28.6	0.7	21.7	27.6	0	0.7	16.6	0	17.3
	527	7	T	14.1	0	15.3	5.9	13.5	7.9	10.3	21.5	1.4	0.4	8.8	1.4	24.6
Upper Fraser River	665		M	0.1	0	3.4	3.2	9.9	33.1	2.6	42.9	0	0	4.5	<.1	18.5
	894		F	0	0	1.3	0	18.8	12.6	1	64.2	<.1	0	2.0	0	12.4
	1,559	15	T	0.1	0	2.4	1.4	14.7	21.5	1.6	55.4	<.1	0	3.0	<.1	16.3
North Thompson River	611		M	0	0	0.2	23.2	1.6	34.0	0	39.2	0.5	0	1.4	0	19.5
	523		F	0	0	0.6	0	3.6	19.8	0.2	73.5	0.6	0	1.7	0	18.7
	1,134	3	T	0	0	0.4	12.8	2.4	27.7	0.1	54.6	0.5	0	1.5	0	19.2
South Thompson River	268		M	1.1	1.1	6.9	13.0	20.7	31.4	7.6	17.5	0	0	0.7	0	34.1
	882		F	0	0	1.1	1.0	27.2	32.0	3.7	34.1	0	0	1.0	0	20.7
	1,150	4	T	0.3	0.3	3.0	5.1	25.7	31.8	4.5	28.4	0	0	0.9	0	25.4
FRASER TOTAL	1,544		M	0.4	0.4	3.5	13.1	10.7	32.3	3.4	33.2	0.2	0	2.2	<.1	24.0
	2,299		F	0	0	1.0	0.3	16.5	21.5	1.6	57.3	0.2	0	1.6	0	17.3
	3,843	22	T	0.1	0.1	1.9	6.4	14.3	27.0	2.1	46.1	0.2	0	1.8	<.1	20.3

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[a] Percentages for Not Readable are from the total sample size; aged fish percentages are derived from the total sample less the not readable proportion.

[b] NG=not given in source report.

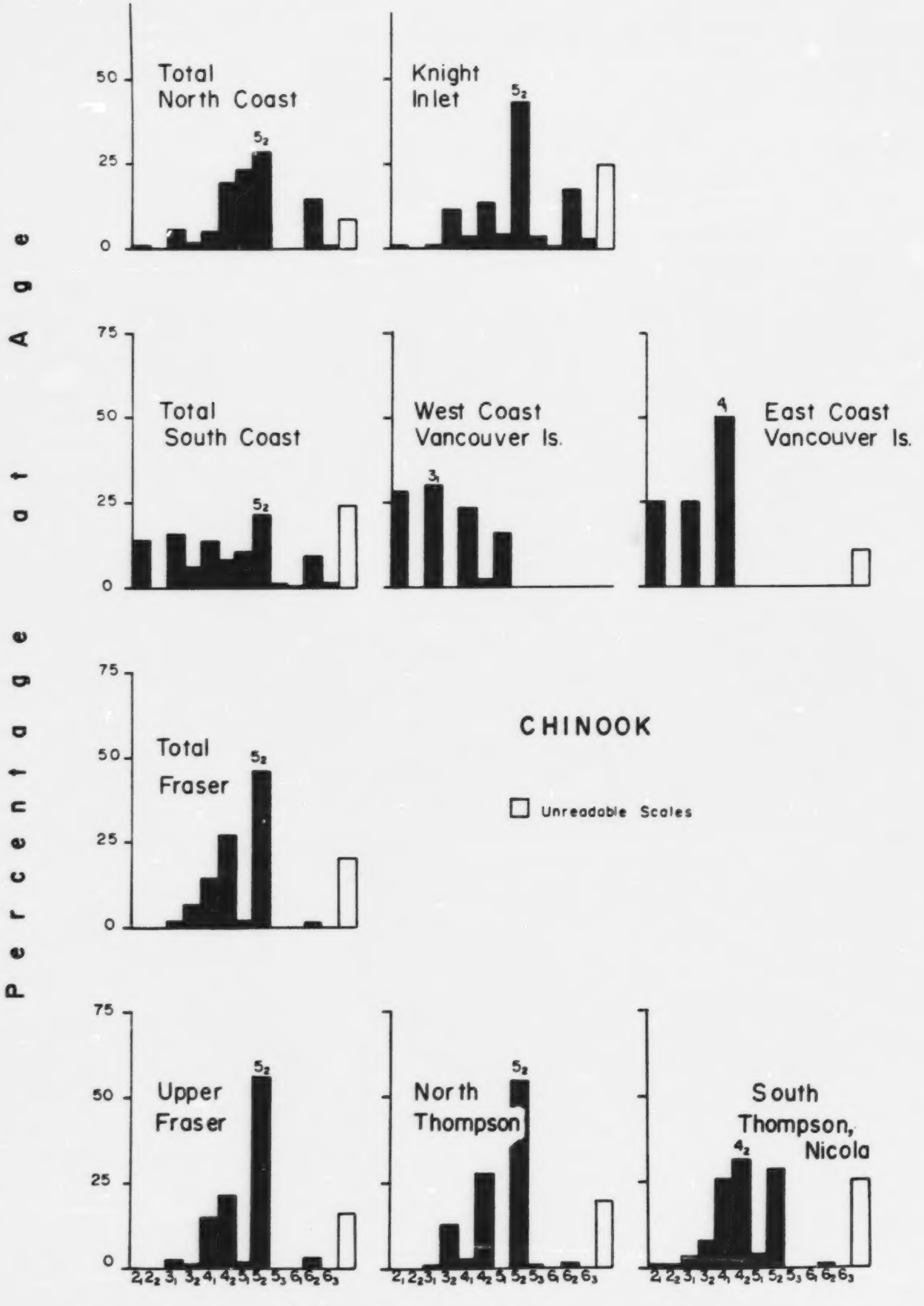

Figure 8. Age composition of CHINOOK salmon stocks, as determined in New Projects studies.

Table 13. Regional summary of COHO age composition results from salmon stocks sampled during New Projects studies.

Area	Sample Size	No. of Streams	Sex	Percentage at Age					Not[a] Readable
				2_2	3_2	3_3	4_2	4_3	
NORTH TOTAL[b]	>104		M	6.5	80.3	0.3	0	12.9	0
	>65		F	0	83.9	0	0	16.2	12.5
	175	4	T	3.3	81.7	0.2	0	14.8	5.0
Knight Inlet	184		M	11.2	64.3	0.7	0	23.8	8.6
	109		F	0	89.6	0	0	10.4	1.8
	293	4	T	8.1	77.8	0.4	0	13.7	4.7
West Coast Vancouver Is.	33		M	4.2	95.8	0	0	0	40.0
	41		F	0	89.4	0	2.3	8.3	52.2
	74	5	T	1.5	92.1	0	1.5	5.0	48.5
East Coast Vancouver Is.	37		M	0	100.0	0	0	0	29.7
	26		F	0	100.0	0	0	0	38.5
	63	1	T	0	100.0	0	0	0	33.3
SOUTH TOTAL	254		M	5.1	86.7	0.2	0	7.9	26.1
	176		F	0	93.0	0	0.8	6.2	30.8
	430	10	T	3.2	90.0	0.1	0.5	6.2	28.8
North Thompson River	131		M	0	94.8	0	0	5.3	3.4
	239		F	0	91.9	0	0	8.1	9.0
	370	6	T	0	93.5	0	0	6.5	6.9
South Thompson, Nicola Rivers	155		M	0	94.5	0	0	5.5	6.0
	186		F	0	99.3	0	0	0.7	6.5
	341	4	T	0	96.6	0	0	3.4	6.4
FRASER TOTAL	286		M	0	94.7	0	0	5.4	4.7
	425		F	0	95.6	0	0	4.4	7.8
	711	10	T	0	95.1	0	0	5.0	6.7

[a] Note that percentages for Not Readable are from the total sample size; aged fish percentages are derived from the total sample less the Not Readable.

[b] Gamsby River sample not divided by sex in source report.

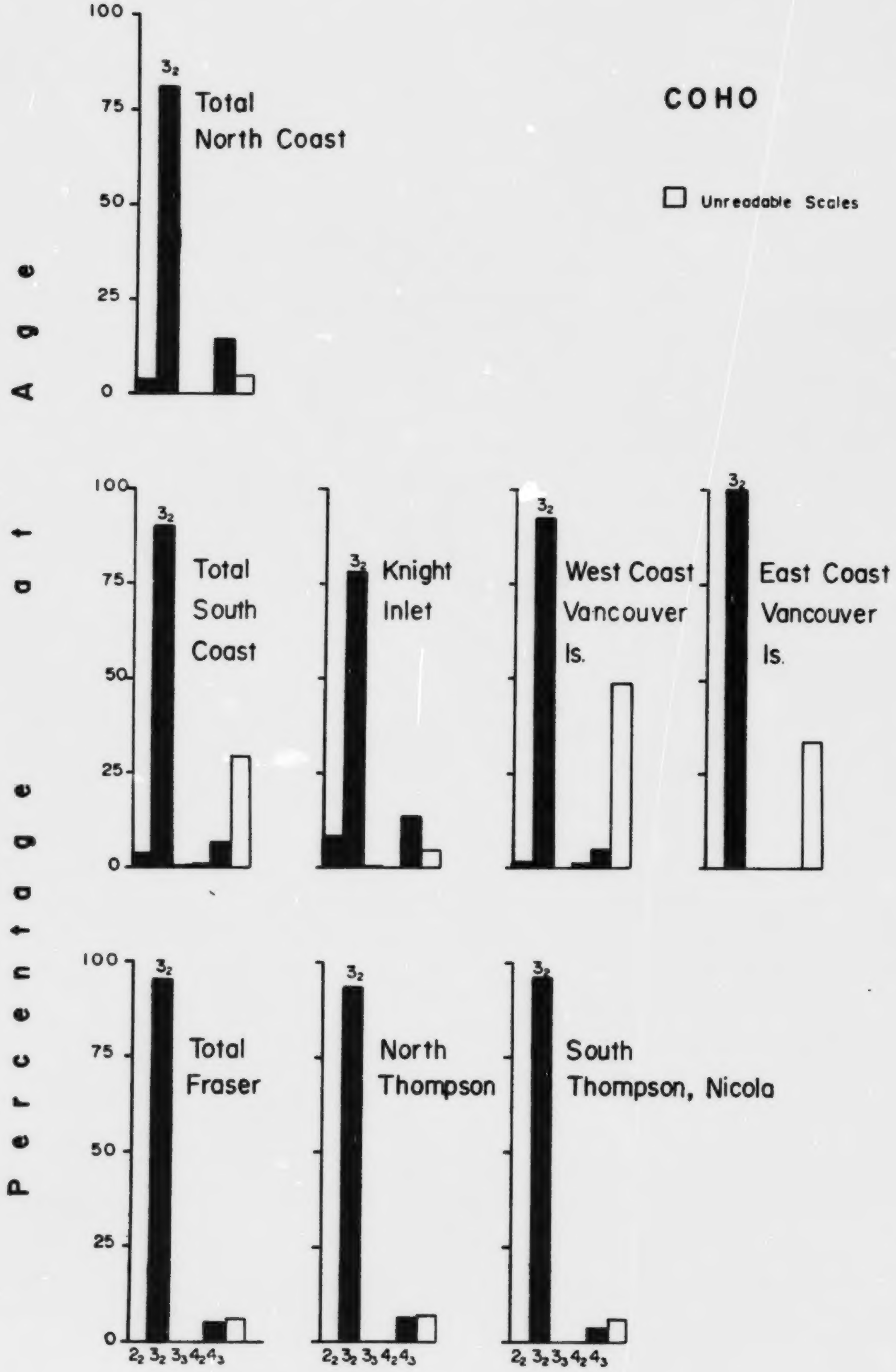

Figure 9. Age composition of COHO salmon stocks, as determined in New Projects studies.

Table 14. Regional summary of CHUM age composition results from salmon stocks sampled during New Projects studies.

Area	Sample Size	No. of Streams	Sex	Percentage at Age					Not[a] Readable
				2_1	3_1	4_1	5_1	6_1	
NORTH TOTAL	579		M	0	29.3	56.6	14.2	0	7.2
	531		F	0	25.7	54.4	19.9	0	8.3
	1,110	5	T	0	26.9	54.9	18.3	0	7.5
Knight Inlet	123		M	0	25.0	57.3	17.8	0	3.2
	87		F	0	26.4	47.5	26.8	0	1.0
	210	4	T	0	26.2	54.4	19.4	0	3.0
West Coast Vancouver Is.	905		M	0.1	13.9	82.5	2.7	0.8	NG[b]
	610		F	0	12.4	84.0	3.1	0.5	NG
	1,515	6	T	<.1	13.1	83.2	3.0	0.6	NG
East Coast Vancouver Is.	204		M	0	13.4	84.6	2.0	0	1.5
	201		F	0	7.7	91.3	1.0	0	3.0
	405	1	T	0	10.6	87.9	1.5	0	2.2
SOUTH TOTAL	1,232		M	<.1	17.4	74.8	7.5	0.3	2.4
	898		F	0	15.5	74.3	10.3	0.2	2.0
	2,130	11	T	<.1	16.6	75.2	8.0	0.2	2.6

[a] Note that percentages for Not Readable are from the total sample size; aged fish percentages are derived from the total sample less the Not Readable.

[b] NG=not given in source report.

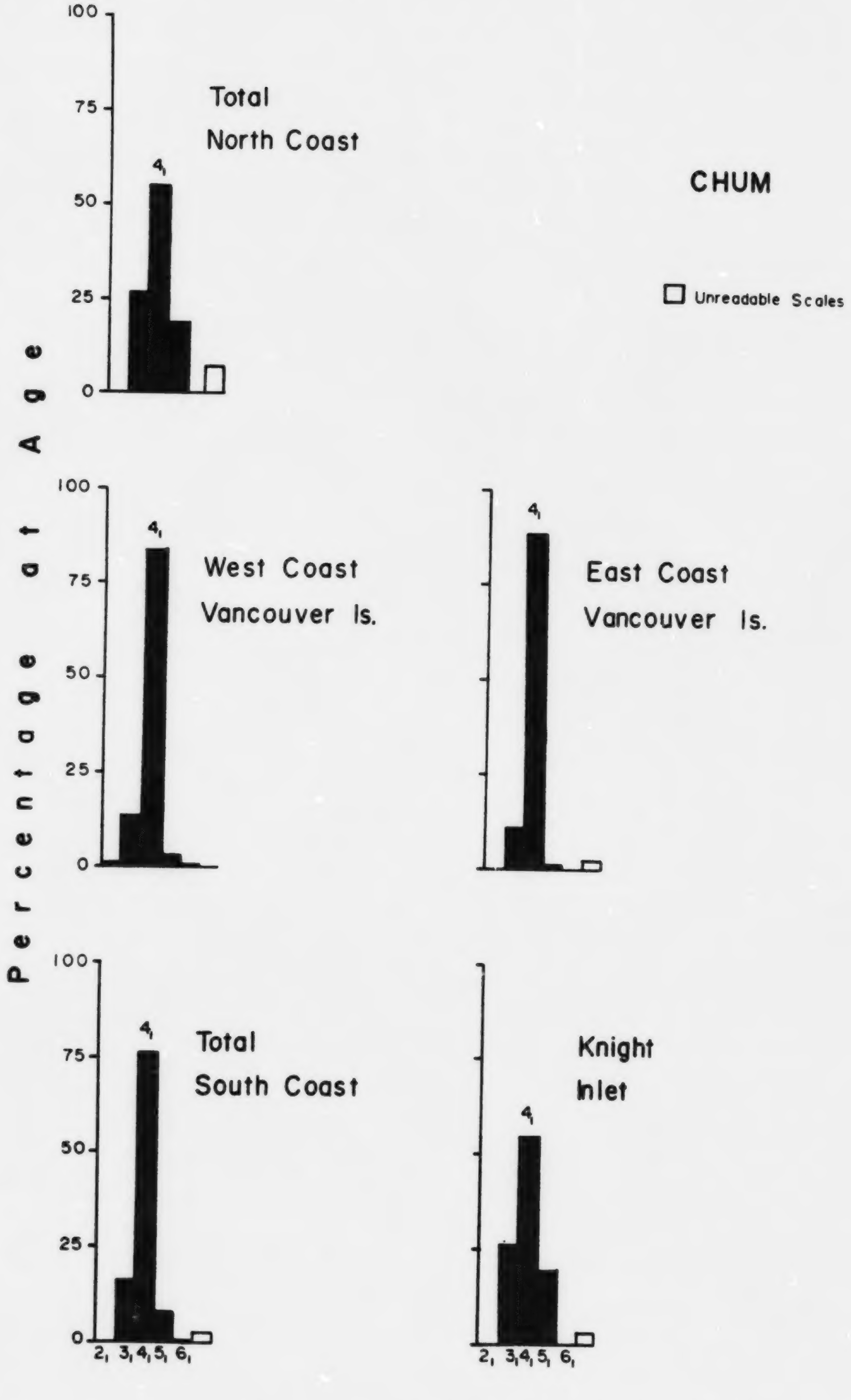

Figure 10. Age composition of CHUM salmon stocks, as determined in New Projects studies.

Table 15. Regional summary of SOCKEYE age composition results from salmon stocks sampled during New Projects studies.

Area	Sample Size	No. of Streams	Sex	Percentage at Age								Not[a] Readable
				3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_3	
NORTH TOTAL	57		M	3.6	3.6	0	38.8	0.7	42.0	2.1	9.2	0
	50		F	3.6	0	3.6	36.7	0	51.2	0	5.0	0
	107	4	T	3.6	2.1	1.8	36.0	0.4	47.1	1.1	7.8	0
Knight Inlet	41		M	0	0	0	36.7	1.4	38.1	21.1	2.8	0
	27		F	0	0	0	51.0	0	12.0	35.0	2.0	0
	68	2	T	0	0	0	42.0	0.8	29.9	25.0	2.5	0
West Coast Vancouver Is.	58		M	0	4.7	0	75.5	0	18.1	1.9	0	NG[b]
	30		F	0	0	0	78.0	0	18.0	4.0	0	NG
	88	2	T	0	3.2	0	79.3	0	15.1	2.6	0	NG
SOUTH TOTAL	99		M	0	2.4	0	56.1	0.7	28.1	11.5	1.4	0
	57		F	0	0	0	64.5	0	15.0	19.5	1.0	0
	156	4	T	0	1.6	0	60.7	1.4	22.5	13.8	1.3	0
North Thompson River	41		M	0	15.4	0	57.7	0	26.9	0	0	36.6
	11		F	0	0	0	66.7	0	33.3	0	0	18.2
	52	1	T	0	11.4	0	60.0	0	28.6	0	0	32.7
South Thompson, Nicola River	51		M	0	65.8	0	34.2	0	0	0	0	25.5
	19		F	0	23.1	0	76.9	0	0	0	0	31.6
	70	1	T	0	54.9	0	45.1	0	0	0	0	27.1
FRASER TOTAL	92		M	0	40.6	0	46.0	0	13.5	0	0	31.1
	30		F	0	11.6	0	71.8	0	16.7	0	0	24.9
	122	2	T	0	33.2	0	52.6	0	14.3	0	0	29.9

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[a] Note that percentages for Not Readable are from the total sample size; aged fish percentages are derived from the total sample less the Not Readable.

[b] NG=not given in source report.

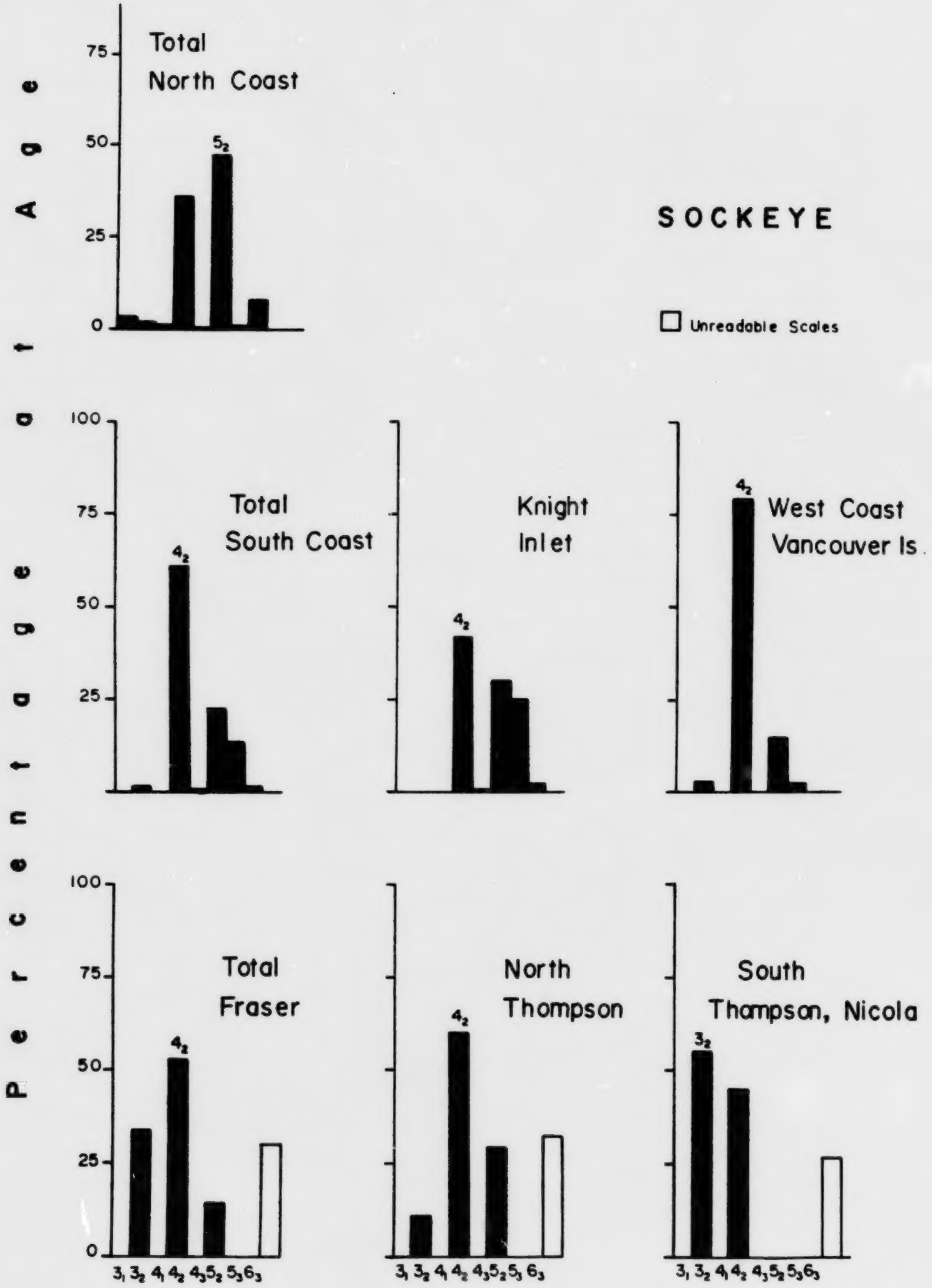

Figure 11. Age composition of SOCKEYE salmon stocks, as determined in New Projects studies.

sex ratio data indicated that sex-linked behaviour biased the overall population sampling, particularly relative to immigration timing and catchability. When such behaviour is combined with sex-specific differences in age of maturation, then the representativeness of the sampling may be questionable. Males and females may have matured at different ages — most obviously in the case of jacks, but this pattern was also evident for sub-1 and sub-2 groups of chinook salmon (Table 16). Coho and chum showed no significant differences in maturation age by sex; there were insufficient data for sockeye.

Chinook (Table 12, Figure 8):

In those cases where chinook salmon were studied for two or more years, there were changes in the age structure (Table 17) recorded for some study streams.

Such shifts between sub-1, sub-2 and sub-3 components may have to do with chinook juveniles being opportunistic as to the duration of their freshwater rearing (see Cues to Migration section). Nechako River chinook stocks have been studied for several years in some detail, although only for one year as part of this series, and significant changes in freshwater life history have been recorded in that system as well (9). Studies on the Finn and Raft Rivers (36, 37) also noted variable life-history patterns from year to year, but sample numbers were too low to make between-year comparisons.

In general, there was wide variation in population age structure for chinook salmon. There were twelve different age groups identified in the studies, with the 5_2 group predominant for the coast when regional summaries were considered. However, there were notable exceptions: the 4_2 group dominated samples taken from the Adams and South Thompson Rivers in 1981 (40, 41), the Quesnel River in 1979 (9); and in the Eagle, Salmon and Raft systems in 1981 (40, 41; 36, 37).

There also seemed to be regional differences in stream-type and ocean-type life histories. Vancouver Island stream samples were almost exclusively sub-1. In the Fraser River studies where chinook were usually the target species and many more fish were sampled for age, sub-2 fish predominated, with the exception of some individual streams noted above.

Coho (Table 13, Figure 9):

Although the 3_2 age group was highly dominant in all areas, there

Table 16. Proportions of the male and female populations maturing at a given age, and the statistical probability that their mean proportions are the same.

Species	Age	N[a]	Proportions of		Probability[b]
			Males $\overline{x}$	Females $\overline{x}$	
Chinook	3_1	11	.009	.005	.4989
	3_2	11	.130	.001	.0010[c]
	4_1	11	.066	.077	.6762
	4_2	11	.300	.157	.0698
	5_1	11	.028	.044	.5923
	5_2	11	.418	.671	.0060[c]
Coho	2_2	9	.052	0	.1569
	3_2	9	.880	.902	.6886
	4_3	9	.063	.098	.5625
Chum	3_1	10	.184	.165	.6492
	4_1	10	.699	.725	.6759
	5_1	10	.111	.107	.5446

[a] Number of streams included in the test. For chinook, each stream where n>50; for coho where n>25; and for chum, where n>40.

[b] Given a Students' t-test for independent samples of population proportions maturing at a certain age, the probability that the difference between sexes is zero.

[c] Statistically significant at the 0.05 level.

Table 17. Selected chinook age structures.

Stream	Year	Predominant Age (%)		Secondary Age (%)		n
Morice	1978	5_1	(28.1)	4_1	(26.3)	71
Morice	1979	5_2	(45.4)	4_1	(9.2)	308
Morice	1980	5_2	(75.3)	4_1	(2.3)	266
Mussel	1981	5_2	(57.1)	3_2	(21.4)	26
Mussel	1983	5_3	(41.4)	4_2	(25.1)	209
Slim	1980	5_2	(74.5)	4_2	(16.4)	110
Slim	1981	5_2	(75.5)	4_2	(22.1)	257
Quesnel	1979	4_1	(69.8)	5_1	(11.1)	63
Quesnel	1980	5_2	(66.9)	4_2	(10.6)	380

may be some geographic differences in age patterns for coho. The north coast studies had the highest proportions of 4_3 fish, including 10% in the Kemano River (n=39; 46, 47) and 17% in Mathers Creek (n=78; 2). Higher 4_3 components were also noted in Knight Inlet (30; 60, 61) and Fraser River (50, 51) areas, although many of these were associated with low sample sizes.

Chum (Table 14, Figure 10):

In most studies where the samples size exceeded 50 fish, the 4_1 age group predominated. The 3_1 age group was predominant in other studies: 68.7% in the Kemano River in 1979 (19, 20) and 53.5% in the Nitinat River in 1978 (10), where the sample sizes were 467 and 105 respectively. No 2_1 or 6_1 fish were present in any system, except for small numbers in the Nitinat River (10). Changes in the chum age structure from year to year were not as large as in chinook, possibly due to low sample sizes in one or both years of study.

Pink:

Pink salmon were aged only in the Mussel Inlet study in 1983 (60, 61) and in the 1981 Thompson River study (40, 41). All were aged 2_1. It was assumed in the other studies that pinks were exclusively 2_1. Given the recent reports of both age 1 and 3 pink salmon spawners in streams of the Great Lakes (Kwain and Kerr 1984), assumption of a rigid two-year life cycle may not have been valid. Additional sampling of Pacific pink stocks is recommended for future studies.

Sockeye (Table 15, Figure 11):

Sockeye were not usually a target species and in most cases less than 50 fish were sampled, except for the Kalitan (46, 47), Kakweiken (31, 32) and Lower Adams Rivers (40, 41). The ower Adams River sample was 55% age 3_2 both male ("jacks") and female ("jills"). Relatively large numbers of jacks in the escapement was a predictor of the largest to date Adams River sockeye return of 9.7 million fish in the following year, contributing to the largest Fraser River sockeye run in recent history (IPSFC 1983).

North coast sockeye sampled in the Gardner Canal (46, 47) and Burke Channel (64, 65) studies were predominantly age 5_2 fish, ranging from 40 to 64% (Tezwa and Kitlope Rivers respectively, 46, 47).

In the Kitlope River (46, 47) 21% of the adult sockeye sampled apparently had migrated directly to sea as fry and returned as 3_1 and 4_1 adults (see also Spawning Distribution section).

Length

Similar to age data, if sex-linked behaviour biased the overall population sampling (particularly relative to immigration timing and sample size) and if males and females matured at different ages, these errors also must have been inherent in length sampling. In general, fork length (FL) was measured on live fish to avoid their injury and postorbital-hypural length (POHL) was measured on carcasses: regressions were calculated and used for conversion where necessary. The source of the equation applied to length conversion for each species and stock is listed (Table 18 and also Appendix C-6, Volume II). Sex was always recorded along with length.

As with age, all the length data have been recalculated. The source report appendices were considered to be the primary authority, and baseline length data were sorted by age. Data for badly decomposed fish were rejected. In most cases, FL-POHL regression equations also were recalculated. Equations developed by the consultants in the source documents were rejected if they were derived from a limited amount of data. Some new equations were developed for this study from the largest possible data set within the source document appendices and all equations were standardized to convert FL to POHL length. Conversions to POHL used these equations unless otherwise noted.

In the recalculated FL-POHL regression equations the value of "a" was been calculated to two decimal places, while the value of "b" was calculated to three decimal places. In a test using a small sample size ($n=9$), the FL value derived from an equation where "a" was accurate to zero decimal places and "b" was accurate to one decimal place was found to be 3.3% higher than the calculated mean. The equation with "a" and "b" to two and three decimal places deviated from the calculated mean by less than 0.1%

The New Projects data indicated significant differences between the POHL length of male and female salmon for chinook and chum salmon, but not for the other species (Table 19 and Figure 12). Although coho and pink salmon are available to fishermen for only one season in their life history, sockeye, chum and particularly chinook salmon may be available through several years of ocean growth and migration. It is widely recognized that commercial gillnet fisheries are inherently size-selective

Table 18. Length regression equations, converting fork length (FL) to postorbital-hypural length (POHL) developed for salmon stocks in New Projects studies.

Species	Reference[a]	Stream	Study Year	Sex	n	Regression Equation	R	Equation Source[b]
CHINOOK	46,47	Kitlope	1981	M	10	POHL = 55.58 + 0.709 FL	0.99	CS
	46,47	Kitlope	1981	F	4	POHL = 189.39 + 0.610 FL	0.98	CS
	46,47	Kitlope	1981	T	41	POHL = 71.10 + 0.705 FL	0.99	CS
	42,43	Holmes	1981	M	3	POHL = 351.43 + 0.486 FL	0.98	CS
	42,43	Holmes	1981	F	8	POHL = -85.75 + 0.927 FL	0.96	CS
	42,43	Holmes	1981	T	11	POHL = 42.40 + 0.774 FL	0.98	CS
	42,43	Torpy	1981	M	22	POHL = 23.43 + 0.790 FL	0.95	CS
	42,43	Torpy	1981	F	33	POHL = 19.48 + 0.806 FL	0.96	CS
	42,43	Torpy	1981	T	55	POHL = 33.13 + 0.786 FL	0.95	CS
	42,43	Walker	1981	M	28	POHL = 19.61 + 0.775 FL	0.99	CS
	42,43	Walker	1981	F	28	POHL = 31.78 + 0.867 FL	0.95	CS
	42,43	Walker	1981	T	56	POHL = 15.67 + 0.796 FL	0.96	CS
	23,24	Slim	1980	M	UK[c]	POHL = -2.61 + 0.833 FL	UK	
	23,24	Slim	1980	F	UK	POHL = -13.12 + 0.980 FL	UK	
	23,24	Slim	1980	T	163	POHL = 13.85 + 0.801 FL	0.96	CS
	42,43	Slim	1981	M	123	POHL = 19.38 + 0.770 FL	0.99	CS
	42,43	Slim	1981	F	152	POHL = 16.42 + 0.792 FL	0.91	CS
	42,43	Slim	1981	T	275	POHL = 10.61 + 0.791 FL	0.97	CS
	23,24	Bowron	1980	M	UK	POHL = -1.37 + 0.794 FL	UK	
	23,24	Bowron	1980	F	UK	POHL = -12.84 + 0.962 FL	UK	
	23,24	Bowron	1980	T	195	POHL = 369.96 + 0.386 FL	0.63	CS
	23,24	Willow	1980	M	16	POHL = 96.78 + 0.681 FL	0.98	CS
	23,24	Willow	1980	F	17	POHL = -0.57 + 0.844 FL	0.90	CS
	23,24	Willow	1980	T	33	POHL = 137.32 + 0.656 FL	0.95	CS
	15	Stuart	1980	M	30	POHL = 19.48 + 0.776 FL	0.99	CS
	15	Stuart	1980	F	35	POHL = 3.50 + 0.818 FL	0.96	CS
	15	Stuart	1980	T	65	POHL = 36.16 + 0.769 FL	0.98	CS
	9	Nechako	1979	T	UK	POHL = 63.88 + 0.684 FL	UK	
	18	West Road	1980	M	12	POHL = -38.69 + 0.835 FL	0.98	CS
	18	West Road	1980	F	5	POHL = 136.99 + 0.637 FL	0.99	CS
	18	West Road	1980	T	17	POHL = -2.37 + 0.798 FL	0.96	CS
	18	Nazko	1980	M	6	POHL = 16.71 + 0.760 FL	0.995	CS
	18	Nazko	1980	F	4	POHL = -49.34 + 0.866 FL	0.99	CS
	18	Nazko	1980	T	10	POHL = 0.22 + 0.792 FL	0.99	CS
	9	Horsefly	1979	M	14	POHL = -126.64 + 0.866 FL	1.00	CS
	9	Horsefly	1979	F	24	POHL = -584.10 + 1.435 FL	1.00	CS
	9	Horsefly	1979	T	38	POHL = -183.36 + 0.967 FL	0.94	CS
	18	Horsefly	1980	M	25	POHL = 25.16 + 0.742 FL	0.98	CS
	18	Horsefly	1980	F	8	POHL = 52.05 + 0.858 FL	0.95	CS
	18	Horsefly	1980	T	33	POHL = 20.90 + 0.754 FL	0.98	CS
	18	McKinley	1980	M	11	POHL = 91.82 + 0.662 FL	0.98	CS
	18	McKinley	1980	F	4	POHL = -54.34 + 0.867 FL	0.94	CS
	18	McKinley	1980	T	15	POHL = 91.57 + 0.677 FL	0.96	CS
	9	Quesnel	1979	F	UK	POHL = -17.77 + 0.766 FL	UK	
	18	Quesnel	1980	M	160	POHL = 13.99 + 0.736 FL	0.996	CS
	18	Quesnel	1980	F	107	POHL = 92.51 + 0.697 FL	0.88	CS
	18	Quesnel	1980	T	267	POHL = 15.82 + 0.766 FL	0.99	CS
	40,41	Eagle	1981	T	122	POHL = 26.12 + 0.749 FL	0.95	CS
	40,41	Salmon	1981	T	97	POHL = -3.49 + 0.795 FL	0.96	CS
	40,41	Lower Adams	1981	M	45	POHL = 39.73 + 0.729 FL	0.99	CS
	40,41	Lower Adams	1981	F	78	POHL = 95.90 + 0.704 FL	0.88	CS
	40,41	Lower Adams	1981	T	123	POHL = 40.40 + 0.754 FL	0.96	CS
	40,41	S. Thompson	1981	M	100	POHL = 28.75 + 0.745 FL	0.98	CS
	40,41	S. Thompson	1981	F	100	POHL = 45.13 + 0.754 FL	0.89	CS
	40,41	S. Thompson	1981	T	100	POHL = 81.74 + 0.706 FL	0.95	CS
	36,37	Finn Creek	1981	M	100	POHL = 19.49 + 0.777 FL	0.97	CS
	36,37	Finn Creek	1981	F	100	POHL = 4.63 + 0.819 FL	0.91	CS
	36,37	Finn Creek	1981	T	200	POHL = 42.54 + 0.763 FL	0.94	CS
	36,37	Raft	1981	M	56	POHL = 11.85 + 0.779 FL	0.98	CS
	36,37	Raft	1981	F	29	POHL = -32.39 + 0.849 FL	0.98	CS
	36,37	Raft	1981	T	85	POHL = 0.06 + 0.801 FL	0.98	CS
	36,37	N. Thompson	1981	M	47	POHL = 5.87 + 0.770 FL	0.995	CS
	36,37	N. Thompson	1981	F	40	POHL = 17.52 + 0.790 FL	0.97	CS
	36,37	N. Thompson	1981	T	87	POHL = 8.35 + 0.783 FL	0.99	CS

/. . .continued

Table 18 (continued).

Species	Reference[a]	Stream	Study Year	Sex	N	Regression Equation	R	Equation Source[b]
COHO	64,65	Kwatna	1983	M	UK	POHL = -72.39 + 0.884 FL	0.94	
	64,65	Kwatna	1983	F	UK	POHL = 68.00 + 0.714 FL	0.97	
	64,65	Kwatna	1983	T	58	POHL = 25.56 + 0.748 FL	0.95	CS
CHUM	2	Mathers	1978	M	UK	POHL = 60.54 + 0.710 FL	UK	
	2	Mathers	1978	F	UK	POHL = 83.62 + 0.690 FL	UK	
	46,47	Kitlope	1981	M	42	POHL = -32.25 + 0.803 FL	0.95	CS
	46,47	Kitlope	1981	F	24	POHL = 32.45 + 0.773 FL	0.96	CS
	46,47	Kitlope	1981	T	66	POHL = 145.52 + 0.604 FL	0.90	CS
	19,20	Kemano	1979	M	258	POHL = 72.51 + 0.680 FL	0.93	CS
	19,20	Kemano	1979	F	317	POHL = 110.80 + 0.653 FL	0.86	CS
	19,20	Kemano	1979	T	575	POHL = 134.98 + 0.610 FL	0.89	CS
	64,65	Kwatna	1983	M	UK	POHL = 22.64 + 0.745 FL	0.93	CS
	64,65	Kwatna	1983	F	UK	POHL = 92.64 + 0.683 FL	0.90	CS
	64,65	Kwatna	1983	T	213	POHL = 121.00 + 0.632 FL	0.92	CS
	64,65	Quatlena	1983	M	UK	POHL = 4.26 + 0.773 FL	0.79	
	64,65	Quatlena	1983	F	UK	POHL =-142.64 + 1.016 FL	0.83	CS
	64,65	Quatlena	1983	T	UK	POHL = 78.29 + 0.716 FL	0.76	
	3	Sucwoa	1978	M	UK	POHL = -81.40 + 0.893 FL	0.87	
	3	Sucwoa	1978	F	UK	POHL = -85.40 + 0.943 FL	0.88	
	3	Canton	1978	M	UK	POHL = -23.60 + 0.794 FL	0.91	
	3	Canton	1978	F	UK	POHL =-285.20 + 1.389 FL	0.72	
	3	Conuma	1978	M	UK	POHL =-260.00 + 1.190 FL	0.67	
	3	Conuma	1978	F	UK	POHL =-157.10 + 1.053 FL	0.68	
	3	Deserted	1978	M	UK	POHL = -59.40 + 0.847 FL	0.70	
	3	Deserted	1978	F	UK	POHL = -90.30 + 0.926 FL	0.76	
SOCKEYE	46,47	Kitlope	1981	M	10	POHL = 16.12 + 0.754 FL	0.95	CS
	46,47	Kitlope	1981	F	13	POHL = -38.11 + 0.870 FL	0.95	CS
	46,47	Kitlope	1981	T	23	POHL = 51.30 + 0.717 FL	0.91	CS
	46,47	Tezwa	1981	M	7	POHL = 72.76 + 0.658 FL	0.996	CS
	46,47	Tezwa	1981	T[d]	9	POHL = 85.78 + 0.646 FL	0.97	CS
	46,47	Kalitan	1981	M	10	POHL = -7.44 + 0.770 FL	0.99	CS
	46,47	Kalitan	1981	F	6	POHL = -22.36 + 0.854 FL	0.78	CS
	46,47	Kalitan	1981	T	16	POHL = -26.96 + 0.827 FL	0.96	CS
	Total North		1981	M	27	POHL = -5.07 + 0.777 FL	0.98	CS
	Total North		1981	F	21	POHL = -2.84 + 0.818 FL	0.94	CS
	64,65	Kwatna	1983	M	7	POHL = 5.60 + 0.763 FL	0.98	
	64,65	Kwatna	1983	F	5	POHL = 8.68 + 0.799 FL	1.00	
	64,65	Kwatna	1983	T	12	POHL = -5.08 + 0.795 FL	0.97	
PINK	64,65	Kwatna	1983	M	UK	POHL = -39.00 + 0.855 FL	0.69	
	64,65	Kwatna	1983	F	UK	POHL =-111.00 + 1.042 FL	0.88	
	64,65	Kwatna	1983	T	273	POHL = 60.22 + 0.678 FL	0.89	CS
	50,51	S. Thompson	1982	M	7	POHL = -53.17 + 0.852 FL	0.97	CS
	50,51	S. Thompson	1982	F	15	POHL = 70.50 + 0.684 FL	0.83	CS
	50,51	S. Thompson	1982	T	22	POHL = 115.66 + 0.592 FL	0.84	CS

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[a] Reference document number (see Appendix A-1).

[b] Equations that have been developed in the current study, from appendix information in the source documents, are noted "CS". All other equations are found in the reference documents.

[c] Unknown.

[d] Too few females for regression.

Table 19. Lengths of male and female populations maturing at a given age, and the statistical probability that their mean lengths are the same.

Species	Age	No. of Streams[a] Male	Female	Mean POHL (cm) Male	Female	Probability[b]
CHINOOK	3_1	8	7	537	582	NS[c]
	3_2	13	3	386	453	0.076
	4_1	13	15	721	716	NS
	4_2	15	15	574	610	0.011
	5_1	7	9	749	766	NS
	5_2	15	15	718	704	NS
	6_2	9	7	838	783	0.001
	5_3 and 6_3	4	3	714	685	NS
	NR[d]	14	16	642	682	0.048
	All Ages	16	15	629	695	0.007
COHO	2_2	5	0	309	---	----
	3_2	20	20	479	502	NS
	4_3	10	8	513	490	NS
	NR	10	12	440	472	NS
	All Ages	21	23	480	501	NS
CHUM	3_1	15	14	556	547	NS
	4_1	17	20	620	583	0.003
	5_1	15	16	618	625	NS
	6_1	1	1	629	618	----
	NR	4	4	623	547	0.033
	All Ages	19	21	608	580	0.004
PINK	2_1	16	16	418	411	NS
SOCKEYE	3_2	4	1	352	436	----
	4_2	8	9	460	472	NS
	4_3	1	0	270	---	----
	5_2	8	6	518	507	NS
	5_3 and 6_3	6	3	497	477	NS
	NR	0	0	---	---	----
	All Ages	9	9	468	482	NS

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[a] Number of streams used in this test. Average POHL for each population and age were taken from Appendix C-6. All possible data were included, however not all streams and studies recorded POHL data for a given age.

[b] Given a Student's t-test for independent samples of POHL measured at a certain age, the probability that there is no difference between sexes.

[c] NS=not significantly different ($p<0.100$).

[d] NR=not readable scales.

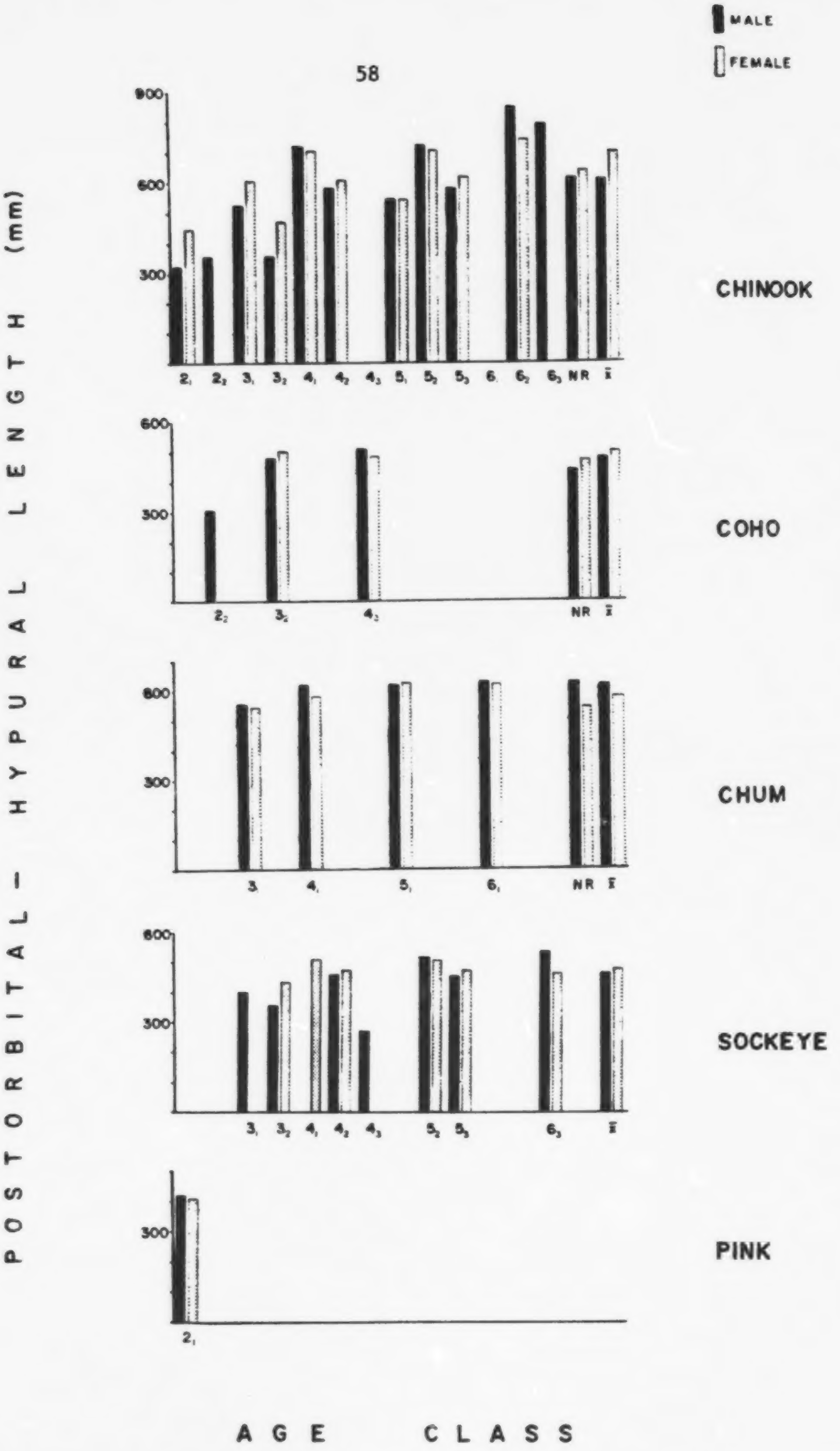

Figure 12. Postorbital-hypural lengths of male and female salmon, by species, as determined in New Projects studies.

and commercial troll and sport fisheries are regulated on the basis of expected seasonal growth rates for certain waters (Argue et al. 1983). It is possible that fishing pressure, acting as an added selective mortality factor, was an element in accentuating certain size and sex patterns among spawning populations.

Length at age data are presented by individual stocks in Appendix C-6 (Volume II) and by regional groupings for each species in Tables 20 - 24. As with age data, each stream was given equal weight in order to avoid skewing the results in favor of large spawning populations which were more intensively sampled. For this summary report, we have avoided regional comparison of lengths due to the possible confounding factor of fishery effects which would primarily affect length data but only secondarily affect age data.

Chinook (Table 20):

There were differences in size between male and female chinook of a given age, but these differences were not consistent. Females were significantly larger than males when all ages were grouped, but when component age groups were considered, females were significantly larger only in the 4_2 age class, while males were significantly larger in the 6_2 class. Among the chinook populations sampled, it appears that females grew more quickly in the early ocean years (to 4_2) but males became larger thereafter. Accelerated earlier growth of female chinook is one of the forces behind current research to develop sex-controlled chinook stocks for aquaculture (Alderdice et al. 1984). Since ages 6_1 and older were sampled less intensively due to fewer individuals in the populations, this may explain the greater length of females in the overall chinook population. The reader is reminded, however, that freshwater scale characteristics for chinook are often difficult to interpret (Tutty and Yole 1978; Yole DFO, Vancouver, pers. comm.) and confusion in this area would confound total age determination as well as freshwater age.

Chum (Table 21):

Chum salmon males were significantly larger than females in the overall population and in the 4_1 age class. Note that for chum salmon, fish aged 3, 4, and 5 were approximately the same size, indicating a threshold size necessary for sexual maturation, although significant differences do exist between lengths of the three age groups ($p<.01$). Studies on chum salmon morphology in southern British Columbia also indicated faster-growing males, as well as different ages at maturation between males and females (Beacham et al. 1983; Beacham 1984).

Table 20. Average postorbital-hypural lengths (POHL) of CHINOOK by age class, as determined in New Projects studies.

Area	Sample Size	No. of Streams	Sex	Average POHL at Age (mm) 2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	Not Readable	Overall Average Length
NORTH TOTAL	290		M	369		577	395	725	581	867	776			860	805	671	714
	397		F			564	331	718	666	814	753			776	812	729	748
	687	2	T	369		575	389	704	583	852	761			804	809	714	731
Knight Inlet	129		M	350		493	448	650	534	550	749	500		880		579	571
	129		F					607	597	740	736			652		713	753
	258	2	T	350		493	448	642	535	736	741	500		766		634	656
West Coast Vancouver Island	147		M	375		468		737	651	825							558
	113		F	448		621	597	713		764							771
	260	6	T	378		471	597	724	651	793							630
East Coast Vancouver Island	5		M	363		608		780									544
	4		F					760								760	760
	9	1	T	363		608		765								760	640
SOUTH TOTAL	281		M	363		523	448	722	593	688	749	500		880		579	558
	246		F	448		621	597	693	697	752	736			652		737	761
	527	9	T	364		524	523	710	593	765	741	500		766		697	642
Upper Fraser	693		M	305		484	352	708	585	747	754			849	800	684	676
	1016		F			631		720	613	713	706	595		798		686	691
	1709	14	T	305		556	352	719	601	715	719	595		836	800	684	681
North Thompson	704		M			550	337	753	595		732	620		838		606	602
	564		F			618		736	609	770	711	648		816		673	689
	1268	3	T			595	337	733	601	770	719	635		832		634	641
South Thompson, Nicola	265		M	305	355	519	367	689	564	771	658			830		605	593
	878		F			550	430	691	599	741	674			747		649	647
	1143	4	T	305	355	544	369	693	591	752	673			756		628	626
FRASER TOTAL	1662		M	305	355	518	352	717	581	759	715	620		839	800	632	624
	2458		F			600	430	712	607	741	697	622		787		669	676
	4120	21	T	305	355	565	353	715	598	746	704	615		808	800	649	649

Table 21. Average postorbital-hypural lengths (POHL) of CHUM by age class, as determined by New Projects studies.

Area	Sample Size	No. of Streams	Sex	Average POHL Length at Age (mm)					Not Readable	Overall Average Length
				2_1	3_1	4_1	5_1	6_1		
NORTH TOTAL	587		M		564	630	644		571	621
	546		F		560	595	615		522	591
	1133	6	T		560	614	631		563	605
Knight Inlet	113		M		543	630	628		629	605
	75		F		564	579	628		605	595
	188	4	T		544	607	627		626	598
West Coast Vancouver Island	905		M	407	556	594	584	629		589
	610		F		529	580	635	618		572
	1515	6	T	407	546	590	618	624		578
East Coast Vancouver Island	204		M		560	598	623			593
	401		F		580	587	600			584
	205	1	T		567	592	615			588
SOUTH TOTAL	1222		M	407	553	607	612	629	629	596
	886		F		558	582	621	618	605	584
	2108	11	T	407	552	596	620	624	626	588

Table 22. Average postorbital-hypural lengths (POHL) of SOCKEYE by age class, as determined in New Projects studies.

Area	Sample Size	No. of Streams	Sex	Average POHL length at Age (mm)								Not Readable	Overall Average Length
				3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_3		
NORTH TOTAL	57		M	400	290		435	270	534	413	540		472
	50		F			510	480		513		486		494
	107	4	T	400	290	510	456	270	521	413	532		479
Knight Inlet	5		M				458		528	460			486
	2		F				445			510			478
	7	1	T				454		528	485			484
West Coast Vancouver Island	58		M		429		497		475	488			487
	30		F				467		489	435			470
	88	2	T		429		482		471	462			479
SOUTH TOTAL	63		M		429		478		502	474			487
	32		F				456		489	473			474
	95	3	T		429		468		500	474			482
North Thompson	41		M		328		491		529				476
	11		F				463		501				475
	52	1	T		328		483		521				476
South Thompson, Nicola	51		M		361		433						386
	19		F		436		484						473
	70	1	T		369		455						410
FRASER TOTAL	92		M		345		462		529				431
	30		F		436		474		501				474
	122	2	T		349		469		521				443

Table 23. Average postorbital-hypural lengths (POHL) of COHO by age class, as determined in New Projects studies.

Area	Sample Size	No. of Streams	Sex	POHL Average Length at Age (mm)				Not Readable	Overall Average Length
				2_2	3_2	4_2	4_3		
NORTH TOTAL	90		M	286	539		555		531
	44		F		540		550	598	549
	134	3	T	286	540		552	598	536
Knight Inlet	82		M	320	498		574	503	495
	46		F		515			460	513
	128	4	T	320	512		574	500	499
West Coast Vancouver Island	21		M	329	527				497
	28		F		552	611			551
	49	3	T	329	536	611			527
East Coast Vancouver Island	37		M	325	488			476	484
	26		F		477			484	479
	63	1	T	325	484			480	482
SOUTH TOTAL	140		M		504		574	490	492
	100		F		515	611		472	514
	240	8	T		511	611	574	490	503
North Thompson	130		M		438		455	388	438
	240		F		462		452	452	455
	370	8	T		447		453	441	448
South Thompson, Nicola	155		M		459		468	426	457
	186		F		472		509	479	473
	341	5	T		465		481	451	464
TOTAL FRASER	285		M		449		462	407	448
	426		F		467		481	466	464
	711	12	T		456		467	446	456

Table 24. Average postorbital-hypural lengths (POHL) of PINK salmon, as determined in New Projects studies.

Area	Sample Size	No. of Streams	Sex	Average POHL Length (mm)
NORTH TOTAL	959		M	417
	654		F	413
	1613	4	T	414
Knight Inlet	450		M	428
	352		F	421
	802	4	T	424
West Coast Vancouver Island	105		M	377
	254		F	372
	359	4	T	374
SOUTH TOTAL	555		M	403
	606		F	397
	1161	8	T	399
North Thompson	0		M	
	0		F	
	6	1	T	425
South Thompson, Nicola	22		M	451
	41		F	442
	63	2	T	445
FRASER TOTAL	22 +		M	451
	41 +		F	442
	69	3	T	435

Sockeye (Table 22):

There were nine different age groups noted for sockeye and many different mean lengths for male and female populations; however, none of these differences were statistically significant. Since sockeye were never the target species and only 324 fish were measured over nine study streams, it is probable that the data is not very representative.

Coho (Table 23) and Pink (Table 24):

There were no significant differences between the lengths of males and females of these species. It is probable that slower-growing individuals reach maturity at an older age, so that the factors governing differences in growth rate that may have affected the maturation size of these species have not been identified. Kwain and Kerr's studies on pink salmon in the Great Lakes (1984) indicate that males generally mature at a younger age than females and that the observed delays in maturity in the lake environment (see Age section) may be attributed to the slower-growing oligotrophic environment.

cundity

Few or no fecundity samples were taken, primarily due to conservation concerns. In total, only 80 chinook were actually examined for fecundity although the bulk of the reconnaissance effort was directed to this species. Similarly, only 26 coho, 26 pink and 107 chum were examined - no direct attempt was made to establish sockeye fecundity (Appendix C-7, Volume II).

While all studies attempted to take fecundity samples over a representative size range, the low numbers of fish sampled probably resulted in some biases. Unspawned females were sacrificed and the egg skeins normally were removed and stored either frozen or in formaldehyde (frozen eggs were boiled for counting). Eggs were usually counted individually but some studies employed less preferable volume or weight sub-sampling methods. Variability in amounts of residual skein tissue probably made the latter method less accurate.

Regression equations were calculated for various stocks of each species except sockeye (Table 25). All studies were faced with an overall lack of samples and equations were often rejected or data pooled and applied as considered appropriate for each study. The choice of straight line or log-transformed equation remains a matter of professional opinion based on "goodness of fit" to the observed data. None of the studies

Table 25. List of regression equations used to derive fecundity, as determined in New Projects studies.

Stream	Reference[a]	n	Fecundity (F) vs. length (POHL in mm.) regression
CHINOOK			
Quesnel[b]	18	18	$F = 12.930\ \text{POHL} - 2{,}655$
Mussel	60,61	6	$F = 59.260\ \text{POHL} - 27{,}986$
Nitinat	10	15	$\log_{10}F = 1.327 \log_{10} \text{POHL} + 1.193$
Nechako	9	3	$F = 20.830\ \text{POHL} - 7{,}389$
Pooled data[c]		80	$F = 2.065\ \text{POHL} + 4{,}410$
Pooled data		80	$\log_{10}F = 0.241 \log_{10} \text{POHL} + 3.068$
COHO			
Kakweiken	31,32	9	$F = 3.850\ \text{POHL} + 1{,}060$
Kwatna	64,65	10	$\log_{10}F = 1.640 \log_{10} \text{POHL} - 1.08$
CHUM			
Tlupana Inlet[d]	3	16	$\log_{10}F = 1.662 \log_{10} \text{POHL} - 1.148$
Deserted	3	12	$\log_{10}F = 0.482 \log_{10} \text{POHL} + 2.07$
Mathers	2	14	$\log_{10}F = 1.096 \log_{10} \text{POHL} + 0.411$
Kemano	19,20	8	$\log_{10}F = 1.700 \log_{10} \text{POHL} + 0.47$
Ahnuhati	60,61	8	$F = 18.860\ \text{POHL} - 8{,}471$
Nitinat	10	15	$\log_{10}F = 1.987 \log_{10} \text{POHL} - 0.072$
Little Qualicum	5	33	$F = 127.800\ \text{POHL} - 4{,}410$
PINK			
Glendale, Tom Browne	60,61	8	$F = 14.050\ \text{POHL} - 4{,}558$
Ahnuhati	60,61	9	$F = 14.120\ \text{POHL} - 4{,}198$
Kwatna	64,65	8	$F = 1.240\ \text{POHL} + 1{,}313$

[a] Reference document number (see Appendix A-1).

[b] This equation has also been applied to the Westroad, Cottonwood, Horsefly, Eagle, Salmon and lower Adams chinook populations and was also used in conjunction with direct egg counts in the Finn, Raft and North Thompson Rivers.

[c] Pooled data from all New Projects studies in Appendix C-7 (Volume II).

[d] Data was pooled from four separate river systems.

had enough chinook fecundity samples to determine that a log relationship had an advantage in reducing error a given distance from the mean.

The fecundities described in Tables 26 and 27 were extracted directly from the source reports. "Observed mean fecundity" was averaged from the field samples and "calculated population fecundity" was determined by inserting mean female POHL in the POHL-fecundity equations. The reader is reminded that this approach may not be valid, especially for chinook salmon (see below). In particular, regression error increases as it deviates from the population mean, so that an equation based on a stock of fish of a certain mean length or fecundity may be inaccurate when transferred to a population with different means. Similarly, it would be a poor practise to determine the fecundities of very large or small fish at the extremes of the regression graph, or to use an equation without establishing the size range of the samples used to derive it.

Chinook (Table 26, Figure 13):

The variation in population fecundity was wide for chinook salmon, ranging from 3,900 to 8,000 eggs. Due to lack of field samples, the Quesnel River chinook equation was used to establish fecundities of West Road, Cottonwood and Horsefly chinook stocks (18) as well as North and South Thompson River stocks (35, 36, 40, 41) even though the mean observed fecundities for the Thompson were 20% lower in value.

All the New Projects chinook fecundity data were pooled to derive an overall equation, listed in both log-transformed and linear format (Table 25). Both equations showed a low correlation value ($r=.09$), indicating that the observed variation in fecundity is not well explained by the variation in POHL. This is consistent with inter- and intra-population studies on chinook fecundity where less than 50% of the variation in fecundity could be explained by variation in length (Healy and Heard 1984) .

Coho (Table 26):

Coho exhibited a much smaller range in population fecundity than chinook salmon (2,500 to 3,300 eggs). In general, few fecundity samples were taken in New Projects studies, largely due to the early termination of the projects. Several of the New Projects studies were used as source material in Beacham's 1982 study in which he developed a coho equation for the Fraser River:

$$\text{Fec} = 11.45\ \text{POHL (mm)} - 2.649$$

Table 26. Fecundities of chinook stocks sampled during New Projects studies.

Stream/Year	Reference[a]	n	Observed mean fecundity of samples	Calculated population fecundity from mean POHL
NORTH				
Kitlope/1981	46,47	0	-----	8,000[b]
SOUTH				
Mussel/1983	60,61	6	6,100	3,900[c]
Ahnuhati/1983	60,61	1	7,000	-----
Nitinat/1979	10	15	4,900	5,000
FRASER				
Slim/1980	23,24	8	6,600	-----
Slim/1981	42,43	7	6,100	-----
Bowron/1980	23,24	9	6,300	-----
Willow/1980	23,24	1	6,700	-----
Stuart/1980	15	5	5,200	-----
Nechako/1979	9	3	5,900	6,000
Westroad/1980	18	0	-----	5,300
Nazko/1980	18	0	-----	5,800
Cottonwood/1980	18	0	-----	6,500
Horsefly/1979	9	0	-----	6,000
Horsefly, McKinley/1980	18	0	-----	6,500
Quesnel/1979	9	11	6,300	6,100[d]
Quesnel/1980	18	7	6,700	5,300
Eagle/1981	40,41	0	-----	4,800
Salmon/1981	40,41	0	-----	6,300
Lower Adams/1981	40,41	0	-----	6,400
Finn/1981	36,37	2	5,300	6,300
Raft/1981	36,37	3	4,900	5,800
North Thompson/1981	36,37	2	5,300	6,500

[a] Reference document number (see Appendix A-1).

[b] Assumed fecundity based on length similarities with Kitimat River stocks (Hilland et al. 1981).

[c] Samples taken over restricted length range (mean POHL 74.4 cm).

[d] Regression equation adjusted after 1980 study to include new data. 1979 population fecundity was changed in the source document from 5,800 to 6,100.

Table 27. Fecundities of coho, chum and pink stocks sampled during New Projects studies.

Stream/Year	Reference[a]	n	Observed mean fecundity of samples	Calculated population fecundity from mean POHL
COHO				
Kwatna/1983	64,65	10	2,800	2,500
Kakweiken/1981	31,32	9	3,300	3,300
Mussel/1981	30	3	3,900	-----
Mussel/1983	60,61	3	3,000	-----
Eagle /1982	50,51	0	-----	3,100
Salmon/1982	50,51	1	3,000[b]	2,600
Lower Adams/1982	50,51	0	-----	2,800
Upper Adams/1982	50,51	0	-----	2,400
Coldwater/1982	50,51	0	-----	2,800
CHUM				
Mathers/1978	2	14	2,700	2,700
Kitlope/1981	46,47	0	-----	3,100[c]
Kemano/1979	19,20	8	2,800	2,900[d]
Kwatna/1983	64,65	1	3,000	-----
Ahnuhati/1983	60,61	8	2,900	2,700
Sucwoa/1978	3	6	1,969-3,422[e]	2,800
Canton/1978	3	4	1,969-3,422	2,700
Conuma/1978	3	3	1,969-3,422	2,700
Tlupana/1978	3	3	1,969-3,422	2,700
Deserted/1978	3	12	2,500	2,500
Nitinat/1979	10	15	2,500	2,600
Little Qualicum/1979	1	33	2,900	3,100
PINK				
Kakweiken/1981	31,32	1	1,600	-----
Glendale, Tom Browne/1983	60,61	8	1,500	1,300
Ahnuhati/1983	60,61	9	1,800	1,600
Kwatna/1983	64,65	8	1,300	1,800

[a] Reference document number (see Appendix A-1).

[b] Pre-spawning mortality (presumed no egg loss before sampling).

[c] Average female POHL was 40 cm greater than Kemano R. The consultant inserted mean POHL for Kitlope females into equations for several systems (Mathers (2); Tlupana (3); Little Qualicum (5); Kemano (19,20) and averaged the results.

[d] Consultant considered that the calculated fecundity was unacceptable due to a wide 95% confidence interval (920-9076).

[e] Direct egg counts were made; fecundity and POHL data were pooled from four Tlupana Inlet streams to develop equation.

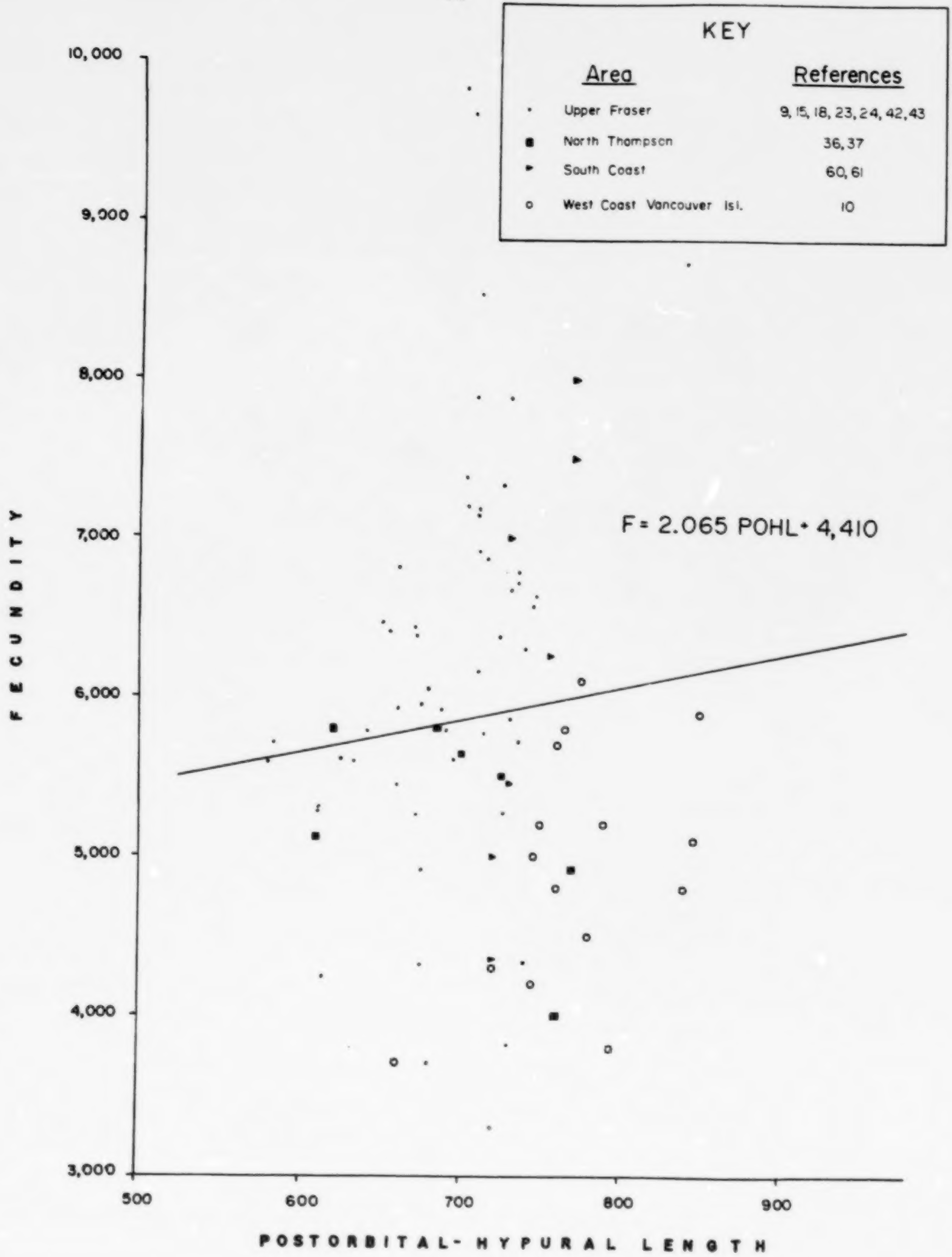

Figure 13. Fecundities and postorbital-hypural lengths of chinook salmon, as determined in New Projects studies (n=80).

This equation was applied by contractors to the Eagle, Salmon, Upper and Lower Adams (40, 41) and Coldwater (36, 37) coho stocks.

Beacham (1982) found significant regional and annual variability in fecundities of coho and chum salmon. He suggested that northern stocks are more fecund than southern B.C. stocks for coho of a given POHL and that chum and coho spawning in large rivers may be more fecund than those in smaller streams. Such trends are not obvious from the limited New Projects data. For most of the streams in Beacham's study (1982) fecundity of coho was significantly related to POHL.

Chum (Table 27):

There were more fecundity data for chum salmon as several large populations (Little Qualicum, 1; and Nitinat River, 10) were sampled. Fecundity ranged from 2,500 to 3,100 eggs. As mentioned in the coho section above, Beacham and Starr (1982) also found that fecundity of chum was significantly correlated with POHL and that some variability was apparent by region and stream size. Again, this is not obvious from the New Projects data for chum.

Pink (Table 27):

Pink salmon fecundities ranged from 1,300 to 1,800 eggs and were primarily from central coast populations. There are indications (McDonald MS1979) that even and odd year stocks in the same river system could have different fecundities, and thus at least two successive years of studies should be applied to determine this parameter on a population level.

Egg Diameter:

Several studies examined the diameter of water-hardened eggs retained in fresh carcasses (Table 28). A significant correlation existed between POHL and formalin-preserved egg diameter calculated from 25 chinook females (15):

$$\text{Egg dia (mm)} = 0.07 \text{ POHL (mm)} + 2.2$$

Studies on the Bowron and Willow systems (23, 24) used egg diameters averaged from the literature to estimate egg numbers from volumes during incubator loading.

Table 28. Egg diameters of chinook and coho stocks sampled during New Projects studies.

Stream	Reference[a]	Mean Diameter[b] (mm)	Range (mm)
CHINOOK			
Torpy	42,43	7.2[c]	-
Slim	42,43	7.3[c]	-
Walker	42,43	7.5[c]	-
Stuart	15	7.4	-
Nechako	9	6.6[d]	6.4 - 6.7
Quesnel	9	7.3[d]	6.6 - 7.9
Quesnel	18	7.8	7.3 - 8.4
Finn	36,37	7.3	6.5 - 8.0
Raft	36,37	7.2	6.8 - 7.7
North Thompson	36,37	7.5	6.4 - 8.7
Eagle	40,41	7.2	5.7 - 8.9
Salmon	40,41	7.0	6.5 - 7.3
Adams	40,41	7.9	7.2 - 8.6
South Thompson	40,41	7.7	6.2 - 9.0
Mussel	60,61	7.1	6.9 - 7.5
Klinaklini	60,61	7.5	-
Ahnuhati	60,61	8.1	7.1 - 8.5
COHO			
Eagle	50,51	6.1	-
Salmon	50,51	6.0	-
Lower Adams	50,51	6.4	-
Upper Adams	50,51	5.9	-
Coldwater	50,51	5.8	-
Mussel	60,61	5.6	5.8 - 6.4
Ahnuhati	60,61	8.1	-
CHUM			
Ahnuhati	60,61	7.5	-
Glendale, Tom Browne	60,61	7.6	-
PINK			
Ahnuhati	60,61	6.0	-
Glendale, Tom Browne	60,61	6.1	-

[a] Reference document number (see Appendix A-1).

[b] Water-hardened diameter, except where noted.

[c] Samples from carcasses, age uncertain.

[d] Samples from formalin-preserved egg retentions.

Egg Retention

Egg retention was estimated in order to calculate an egg loss factor to derive overall egg deposition for a group of spawners. Egg retention was established by estimating the number of eggs left in the body cavity of moribund females and carcasses, either in terms of actual numbers or as a percent of the assumed fecundity. Egg loss through predation or redd superimposition is not considered at this stage.

A distinction was usually made between egg retention (eggs left in the body cavity of spawned-out females) and prespawning mortality (PSM - fish dying unspawned) as the latter can be a significant and variable factor. In the Quesnel, Nechako and Horsefly Rivers (9) about 22% of the chinook carcasses were totally or partially unspawned. PSM was at the 30 to 40% level in Raft River sockeye in 1981 and was related to increasing temperature and decreasing discharge (36, 37). In Slim Creek in 1981 (42, 43), 21% of the female chinook carcasses were unspawned, which may have been precipitated by slightly high temperatures in synergy with a threshold level of a parasitic infection. To properly estimate PSM and egg retention levels and their causes, several years of study would be necessary in order to determine environmental stresses and their attendant egg losses.

Egg retention data were standardized as a percent of fecundity, and include PSM in the egg retention statistics provided in Appendix C-8. Based on Foerster's (1968) suggestion that 5% egg retention was "average" for sockeye salmon, the populations listed in Table 28 all had average egg retentions of greater than 5% and represent about 25% of the total data set. These values were usually due to inclusion of PSM in the data rather than by a high rate of egg retention, which appeared to be negligible on a per fish basis.

Chinook Flesh Colour

Adult chinook flesh colour was determined by examination of the gill isthmus when the fish was alive and by examination of the flesh during sampling of fresh carcasses. It should be noted that flesh colour is a highly judgemental factor when applied on deteriorating fish. It is known that flesh colour pales as sexual maturity progresses (Holmes MS1982).

An apparent dominance in white flesh colour occurs in some Upper Fraser and south coast chinook runs (Table 30 and Appendix C-9, Volume II) -- flesh color of north coast chinook had not been sampled in New Projects

Table 29. Average percent retention for those stocks which had 5% or greater egg retention overall.

Stream	Reference[a]	n	Average % Retention	%Comments
CHINOOK				
Deserted	3	11	< 5	
Slim	42,43	16	5	Not including PSM
Slim	42,43	98	37	Including PSM[b]
Nechako	9	14	21	
Quesnel	9	32	13	
Finn	36,37	256	18]	Related to increasing temps.
Raft	36,37	110	15]	and decreasing discharge
COHO				
Salmon	50,51	10	12	Possible disease concern
CHUM				
Kemano	19,20	347	9	
Kwatna	64,65	117	5	
Glendale, Tom Browne	60,61	16	10	
Ahnuhati	30	9	12	
Ahnuhati	60,61	33	15	
SOCKEYE				
Sucwoa	3	12	7	
PINK				
Kitlope	46,47	10	5	
Kakweiken	31,32	111	44	High spawner populations
Glendale, Tom Browne	60,61	98	13	

[a] Reference document number (see Appendix A-1).

[b] Thermal stress, parasites.

Table 30. Chinook flesh colour, as determined in the New Projects studies.

Stream/Year	Reference[a]	n	% Red Flesh
FRASER			
Holmes/1981	42,43	9	0
Torpy/1981	42,43	38	5
West Torpy/1981	42,43	17	0
Walker/1981	42,43	65	5
Slim/1981	42,43	7	29
Nechako/1979	9	22	14
Blackwater/1980	18	17	100
Nazko/1980	18	10	90
Cottonwood/1980	18	7	86
Horsefly/1979	9	3	100
McKinley/1980	18	15	100
Quesnel/1979	9	33	85
Quesnel/1980	18	320	72
Eagle/1981	40,41	118	83
Salmon/1981	40,41	75	95
Lower Adams/1981	40,41	90	122
South Thompson/1981	40,41	817	78
Finn/1981	36,37	506	74
Raft/1981	36,37	228	79
North Thompson/1981	36,37	400	90
SOUTH			
Mussel/1983	60,61	209	52
Klinaklini/1983	60,61	3	0
Ahnuhati/1983	60,61	23	17

[a] Reference document number (see Appendix A-1).

studies up to 1984. It is suspected that flesh colour is related to genetic factors which may be a racial characteristic. No significant difference was found between the incidence of flesh colour for males and females or between years for Quesnel River chinook (9, 18).

Timing through lower Fraser River commercial fisheries is very different for red and white fleshed chinook. Red fleshed fish comprise the vast majority of the chinook catch during late spring and summer while large numbers of white fleshed fish are caught in September and October. Based on flesh colour, sport and native fisheries and preliminary coded wire tag returns, early timing, red fleshed stocks were assumed to be stocks migrating upstream of the Thompson River confluence and late timing, white fleshed stocks to be primarily the large Harrison River run (Fraser et al 1982). However, other stocks (such as upper Fraser runs) may have significant or even dominant white fleshed components; in fact, few Fraser River stocks were found to be 100% red, even where sample sizes were small. These findings may require re-assessment of stock timing curves through the lower Fraser River, in cases where information is based on flesh colour alone.

Genetic control of red and white fleshed characteristics is under investigation at the Quesnel River Hatchery, where both populations co-exist. Hatchery production studies will determine any differences in size and survival of hatchery crosses through coded-wire tagging of the progeny (G. Berezay, DFO, Vancouver, pers. comm.). Controlled experiments are also underway to determine the genetic influence of flesh colour of chinook hybrids from the Quesnel River stock. Preliminary results indicate that the extent to which dietary carotenoid pigments are extracted and incorporated into flesh colour are a genetically controlled event rather than merely a difference in diet (R. Withler, DFO, Nanaimo, pers. comm.).

DISEASE SURVEYS

The purpose of conducting disease surveys was to determine the endemic disease characteristics of the fish populations. Investigations were focussed on those pathogens and parasites known to cause hatchery losses so that the facility feasibility, design and operation could be adjusted accordingly. Several early studies in the north and south coast (2, 3, 5, 7, 19, 20, 56, 57) did not include disease sampling. This work was conducted independently by DFO and therefore is not reported here. Later contracts reflected a more cooperative approach to disease sampling.

Field sampling primarily involved collecting spent live or fresh-dead adult salmon. Juvenile samples were also collected (13, 14, 21, 22, 27, 28, 34, 35, 38, 39) although moribund fry and fingerlings were not normally available in nature; the most revealing analyses were on pen-reared fish (13, 14, 21, 22). While Appendix C-10 (Volume II) describes the results of disease surveys in detail, the Disease Diagnostics Services (DDS) Unit at the Pacific Biological Station in Nanaimo maintains more complete and current listings of all disease survey results which can be accessed upon request.

In the following summary on the various disease agents found, ancillary information on their characteristics and treatment is derived from Wood (1979) and Margolis (1982).

Bacteria

The most common bacterium encountered in these studies was *Aeromonas salmonicida*, the causative agent of furunculosis in salmonid hatcheries. Furunculosis is a well-known disease which causes external lesions and a generalized bacteremia that kills both adult and juvenile fish. Although it is treatable by antibiotics and mortalities are usually limited to less than 20%, a natural disease reservoir usually exists in wild fish populations which may continually re-infect ~~hatchery~~ water supplies or possibly harbour drug-resistant strains. *A. salmonicida* was well-established in several populations (30, 36, 37, 60, 61, 64, 65). Since this bacterium is known to be a major cause of hatchery mortalities, special hatchery practices are required.

Bacterial kidney disease was found in wild pink salmon and other fish species in Tom Browne and Glendale Creeks (33, 60, 61). It was of particular note that several of the fish sampled in Tom Browne Lake were heavily infected with BKD; such levels of infection were considered unusually high for wild populations (G. Hoskins, DFO, Nanaimo, pers. comm.). Although this disease is observed in all salmon species, it is evidently most common in chinook, coho and sockeye due to their extended freshwater rearing period and can be passed to hatchery fish from infected wild fish resident in the water supply.

Viruses

Since viruses are much smaller than bacteria and are only found within their host cells, they are more difficult to detect and study. Although the symptoms of a virally-infected fish may be apparent from on-site visual examinations, definitive diagnosis relies on growing the virus on cultured cells in the laboratory. Thus, only a viral assay can indicate whether or not a given population is certifiably disease-free. In British Columbia, the primary concern is for IHN (infectious hematopoetic necrosis).

IHN is endemic to B.C. sockeye populations and has caused severe losses in U.S. hatchery chinook stocks. Kokanee populations of Mussel Creek were specifically tested for the presence of IHN (60, 61). No incidence of the virus was found on an assay performed on 30 to 60 fish. However, as the specimens were unspawned, many infectious agents including IHN may not have been discovered.

Protozoa

The protozoan disease agents encountered were mostly myxosporidians, which are a large, diverse group of microorganisms. Despite a great deal of investigative work, very little is known of the life histories and transmissiblity of the more than 700 species described as fish parasites. *Ceratomyxa shasta*, *Henneguya salmonicola* and various *Myxidium* species are included in this group.

Ceratomyxa shasta:

The most significant disease presence was that of *Ceratomyxa shasta* throughout the Fraser River drainage, confirming a widespread northern distribution for this protozoan. *C. shasta* has been held responsible for several serious losses at western U.S. trout hatcheries and its discovery in adult spawning stocks not only in the Fraser River but also in the Capilano and Vancouver Island hatcheries, Queen Charlotte Islands and the Yukon prompted supplementary research through the New Projects Unit.

The life history of *C. shasta* is not well known, although there is indirect evidence that an intermediate host must exist. The organism is thought to be transmitted by infected water and is not transmitted by cohabitation with diseased fish or by injection or ingestion of spores or infected tissue. The infective stage appears to be restricted to the lower ends of rivers or reservoirs and the disease can be initiated easily by exposing fish to river water. The rapidity of progress of infection is related to water temperature and the abundance of infectious units (infection can be established with as little as 30 minutes exposure time), but mortality does not begin for at least twenty-one days and can take as long as four months. *C. shasta* cannot be confirmed in fish until an advanced stage when spores have formed and the host is near death.

Initially, the resistance of six Fraser chinook stocks was tested, including the effect of transfer to saline water in disease progression (53). Fish were exposed 5-10 days in cages in the Fraser River near Whonnock and then transferred to constant-temperature tubs. The study indicated that all stocks showed extremely low resistance regardless of size (96% mortality overall), that upriver stocks were equally as susceptible as lower river stocks, and that saltwater acclimation caused fish to die more quickly. *C. shasta* may impair the ability of the fish to osmoregulate (Ching and Munday 1984).

Seasonal testing (55) indicated that, contrary to American studies (Wood 1979), an assumed 10°C threshold appeared to be valid for spring disease onset only; fish exposed in November at 6.5°C became infected, although at a lower rate. A timing "window" appears to be present from sometime after November until late March, when water in the lower Fraser River thought to be carrying *C. shasta* organisms is not infective. This may have some ecological significance in determining chinook migration timing for different stocks and life history patterns (see Juvenile Migrations section).

Additional work was conducted on a stock known to be resistant to the U.S. version of *C. shasta* by exposure to Fraser River waters (59). This stock was exposed to Fraser River water in a quaantine facility. Results showed that the stock was also resistant to the Fraser *C. shasta* strain, suggesting that the resistance of Fraser chinook stocks was lower rather than there being a difference in virulence between the *C. shasta* strains. The DDS Unit has continued work on *C. shasta* in order to determine the significance of this organism for enhancement facilities in the Fraser River.

Other Protozoans:

Henneguya salmonicola is a parasite found in cysts in the body musculature of adult salmon and is thought to be contracted in the marine environment. It was identified in one of 25 samples taken from chinook salmon in the Bowron River (23, 24). Although *Henneguya* is not a health hazard it is objectionable to the consumer and is considered to be a severe marketing problem (Holmes MS1982).

Myxidium spp. were identified in several areas, including Fraser River and central coast fish populations. Although some populations were heavily infected (50% in Quesnel chinook, 18; 90% in Salmon R. chinook, 40, 41; 84% in Kwatna pinks, 64, 65) *Myxidium* was not associated with any fish losses. However, in chinook pen-rearing operations in the Stuart River there was a 22% mortality attributed to an unidentified myxobacterium. Stuart River adults were held in pens to determine their degree of susceptiblity to disease, with good results (15). In the Kwatna River where heavy infestations were found in the renal systems of pink salmon, it was noted that there were low values of water hardness (4.8 - 7.6 mg/l $CaCO_3$) and that hardness of <10 mg/l $CaCO_3$ has been related to kidney disease (Sigma Resource Consultants 1979). Another myxosporidian, *Chloromyxum spp.*, was found in Kwatna River pink salmon (64, 65) and was also identified in Mussel Creek kokanee gall bladder structures (30).

Dermocystidium salmonis is a microsporidian parasite often found on the gills of adult and juvenile chinook in hatchery populations and its severity has been linked to increasing water temperatures. Its presence may make it difficult to hold adults prior to spawning in normal hatchery operations. It may also have caused heavy losses of wild sockeye in the Nimpkish River (Gould and Stefanson 1985) and was recorded found in adult chinook in the Quesnel (18) and Salmon (40, 41) Rivers.

There was also significant mortality of juvenile chinook during pen-rearing at the outlet of Quesnel Lake in 1980 (16, 17). Although no primary causative agent was identified, bacterial gill disease caused by an unclassified myxobacterium was considered to be at least partially responsible for the 21% mortality experienced overall.

Worm Parasites

Worm parasites do not seem to cause hatchery losses and are common on otherwise healthy adult fish. Several nematodes (*Anisakis* spp., *Philonema* spp.) and cestodes (*Diphyllobothrium* spp.) were present in Knight Inlet (30, 60, 61) and South Thompson River (50, 51) fish.

JUVENILE DATA

Seventeen separate field studies on juvenile salmonids examined 57 study streams and approximately 125 different fish populations. Many of the fish sampled were caught incidentally to the target species and although some data were gathered, the information was too incomplete to be used for comparative purposes.

The focus for juvenile studies has changed considerably since contracted field studies began in 1979. Early contracts, such as Little Qualicum (5) and Tlupana Inlet (6) studies, primarily described and enumerated downstream migrant populations. Manageability of some enhanced stocks was also a concern and coded-wire tagging of upriver chinook stocks was priorized in downstream studies (8, 16, 17, 56, 57) so that biological information was addressed secondarily as funds and fish permitted. In later studies, less emphasis was placed on actual numbers of migrants and tagging was eliminated. Terms of reference for juvenile studies, particularly in the interior Fraser, paid more attention to rearing ecology in relation to outplanting of hatchery fry. Estuarine habitats, particularly the Kitimat (11, 12, 26, 27) as well as tributary habitats to larger systems (South Thompson, North Thompson, upper Fraser) began to be examined in the studies. Considerably more estuarine data are now available from studies done during the transition phase (see Appendix A-2). Habitat inventory surveys in earlier studies physically described all areas in a watershed accessible to anadromous fish (eg. Morice Lake, 56, 57). These data were analyzed in later studies to describe habitats in relation to spawning or rearing utilization. Some recent studies concentrated on coho overwintering habitats in the North Thompson (54), juvenile salmonid rearing habitat quality and quantity in the Middle Shuswap (62, 63) and actual and potential habitat utilization in South Thompson tributaries (49A, B).

To design and implement modern enhancement technology in a rapidly-changing world, the New Projects Unit required biological studies at used fairly broad ecological approaches. As new knowledge on pilot tcheries and natural fish populations became available, requirements of venile studies changed from 1979 to the prsent. The following discussion has been split into rearing and migrating components to facilitate comparisons between studies. In fact, migrating and rearing patterns and habitat characteristics are interrelated and these sections should not be reviewed in isolation from one another.

JUVENILE MIGRATIONS

Downstream migrants usually were captured in "passive" traps such as inclined plane traps (IPTs) or fyke nets (FNs). Catches were calibrated for trap efficiency using trap-hours, percent of stream discharge or cross-section fished, and mark recovery trials. Daily population estimates, daily percentage of the run, date of peak catch and environmental factors were then compiled. Since different capture techniques select for various sizes and stages (Conlin and Tutty 1979) it is noted in the appendices where capture methods may have biased the results.

Given the variety of methods that were used in the studies, it was impossible to employ any standardized adjustments for various capture techniques. For example, in the Stuart River, mark recapture trials were used to calibrate two of three downstream traps across three defined migration periods for underyearling chinook fry (13, 14). Since the third trap was primarily designed to assist in obtaining fry for pen-rearing, data were used to record catches of non-target species, to obtain chinook fry quality samples and to assist in the determination of timing curves. Only the consultant on-site at the time could have judged how data from the third trap should be interpreted.

It was necessary to standardize migration timing statistics and definitions of various juvenile life stages in order to compare between studies. A major challenge was differentiating between the timings of emergent and reared fry. This distinction was particularly difficult to make for chum salmon and the reader is advised to use caution when reviewing juvenile statistics for this species. Coho and sockeye 1+ and 2+ juveniles were more clearly defined, usually on the basis of scale readings or size differences. In many cases, where timing dates were based on changes in weight, length or development indices from several different traps within a study, there was disagreement with the conclusions of the source report authors.

Seasonal Timing

The appendix data in the source documents were utilized to adjust the timing information. Not all studies intercepted peak migration due to late startup, trap washout or low catches. Peak timing was defined by the period of highest catch, or when trapping success was highest. In general, the last small or first large samples (length and weight) indicated the beginning and end of the run, unless abnormally large or pinheaded fish were noted. Secondary peaks were not considered, and some degree of trap avoidance by older juveniles must be assumed.

There may be regional differences in the emigration timing for each species (Table 31). Significant differences exist between North and Fraser chinook stocks for emergent fry ($p<0.01$) as well as for 0+ rearing fish ($p<0.05$); northern chinook appeared to migrate two weeks earlier than Fraser stocks. However, for nearly every stream which was studied for two consecutive years and for which the data were comparable, the annual variation was one week or greater for the same species, stock and life history.

Table 31. Timing of fry and smolt outmigrations.

Region	Species	N[a]	Mean Julian Day ± 2 S. E.	Date
EMERGENT FRY:				
North	Chinook	7	106 ± 11	Apr 16
South	Chinook	5	120 ± 15	Apr 30
Fraser	Chinook	20	125 ± 6	May 5
North	Coho	5	150 ± 11	May 30
South	Coho	6	141 ± 12	May 21
Fraser	Coho	10	132 ± 15	May 12
North	Chum	3	119 ± 12	Apr 29
South	Chum	2	113 ± 23	Apr 23
North	Pink	6	99 ± 12	Apr 9
South	Pink	6	105 ± 5	Apr 15
SMOLTS (0+):				
North	Chinook	2	177 ± 30	Jun 26
Fraser	Chinook	9	187 ± 12	Jul 6
North	Chum	3	94 ± 19	Apr 4
SMOLTS (1+):				
North	Chinook	3	119 ± 6	Apr 29
Fraser	Chinook	6	117 ± 11	Apr 27
North	Coho	6	128 ± 21	May 8
South	Coho	5	127 ± 7	May 7
Fraser	Coho	4	121 ± 10	May 1
North	Sockeye	3	134 ± 9	May 14

[a] No. of streams.

Diel Timing

Many studies did not address diel variation in downstream migration timing, but noted generally the proportions of nocturnal and daylight migrations. A comparison of four studies (1, 3, 11, 12, 21, 22) confirms that emergent salmon fry do migrate mainly at night (Appendix C-12, Volume II).

The peak nightly timing varied with the amount of illumination, primarily as a result of lengthening days in the springtime but also related to overcast weather, turbidity and lunar illumination. In the Little Qualicum (5) the proportion of the chum fry migration from 0130 - 0900 h increased as spring progressed:

	% of 24 hour catch		
Migration Dates	2000-0130 h	0130-0900 h	0900-2000 h (PDT)
14-15	89.0	10.0	1.0
21-22	73.8	25.6	0.6
28-29	67.3	32.5	0.2

Quesnel River studies (16, 17) found that although chinook fry peak migrations corresponded with new moon and heavy overcast conditions, coho fry peaks coincided with periods of bright lunar illumination. North Thompson studies (48) correlated both chinook and coho downstream fry migration with cloudy nights, new moon phases and generally low light intensities. Mason (1975) described coho downstream migrations and found that fry migration peaks correlated with new moon phases and smolts when the moon was full. The extent to which seasonal forces (such as accumulated thermal units) override diurnal forces (such as overcast weather) is uncertain. These factors are discussed in more detail later in the text.

The amount of daylight migration seems to increase at the peak of migration. In the Stuart River (13, 14) the greatest diel movement (47%) was recorded at the chinook fry migration peak. Similarly, 80% of Kitimat River pink fry (11, 12) migrated in darkness but during the peak migration from April 8 - 11 the proportion migrating in daylight rose to 25%.

McDonald (1960) suggested that the proportion of daylight migration is related to distance between spawning grounds and tidewater. This agrees with New Projects studies on the Kitimat River system (11, 12), where Kitimat River pink fry captured in the lower mainstem migrated approximately 80% at night, while pink fry in the upriver Hirsch Creek tributary migrated 99.8% at night.

Cues to Migration

Almost all studies associated downstream migration with monitored changes in water temperature and river discharge. However, to identify these factors as migration triggers may be inaccurate. In this discussion, all observations are treated subjectively and the reader is advised to refer to the source documents for more detailed information.

Emergent Fry:

Numerous authors (condensed in Hoar 1976) have shown that several physical factors are important to the timing of the overall migration period of salmon fry, including water temperature, dissolved oxygen, substrate, water flow and the amount of light. Fry migrations for all species studied in this series were often related to physical factors, but no consistent factor was evident. Although chinook and coho emergence peaks were often associated with an initial increase in discharge, this was not the case among adjacent study streams in the North Thompson (34, 35). Other areas, for example Tlupana Inlet streams (6), have associated high fry catches with high discharges, confounded by some obvious inadvertent downstream movement. Temperature was often cited as an associated factor for emergence timing, so that peak emigration occurred during increasing temperatures. Variations in spawning timing were also responsible for variations in emergence timing (eg. coho salmon in the Kitimat River (11, 12). Appendix C-14 (Volume II) basically contains a contradictory list of migration "cues" based on physical factors whose interrelationships are not fully understood.

Water temperature estimated by accumulated thermal units (ATU's) appears to be the primary driver for emergence timing, however the temperature regime must be measured where it is relevant to the incubating fish. In the Glendale R. (67) subgravel temperatures were used to calculate ATUs to emergence and, using this method, peak chum and pink salmon emergence timings were accurately predicted in Glendale and Tom Brown systems (67). Other studies (see Shepherd et al. 1986) suggest that intragravel water temperatures can differ regularly from surface water temperatures and that many factors cause variations in the intragravel thermal regime (eg,. logging, ice dams, tidal influence). Variations in surface water temperature and stream discharge that were correlated with emergence timing may well have been accompanied by variations in intragravel water temperature, perhaps leading to misinterpretation of causal factors governing emergence timing.

Rearing Juveniles:

Growth, microhabitat and complex behavioral and environmental factors were suggested as migration cues in nearly all New Projects studies. Since hatchery enhancement programs for salmonids must consider limiting factors to stream growth and survival, a more detailed examination of potential factors is presented below.

Chapman (1962) found that aggressive behaviour of social dominants was an important factor in the downstream movement of coho fry. Intraspecific competition in streams was not usually cited as the causal factor for migration in the New Projects studies although it may well have been present. More often, increasing summer temperatures and decreasing flows were associated with fry movements into cooler tributaries and side channels (Salmon and Adams Rivers, 38, 39; Finn Creek, 34, 35). In the Adams River, juvenile coho emigrated into sidechannels and tributaries at 19°C and then moved back into the mainstem when temperatures dropped (38, 39). Coho fry emerging from Dunn Creek migrated upstream in large numbers to Dunn Lake, where water temperatures were 12.5°C, in comparison to 8°C at the trap site further downstream (48). A further complication for coho is that when the spawning areas are unknown, it is difficult to interpret the significance of observed fry movements. None of the studies were required to examine in detail juvenile intraspecific behaviour, but all monitored physical factors in conjunction with downstream migrations.

It is difficult to describe the possible causes of chinook downstream migration, even though many New Projects studies specifically addressed chinook stream rearing, distribution and migration patterns. Stein et al. (1972) reported that social interaction between coho and chinook juveniles occurs when both species emerge at a similar time and size within a stream, concluding that chinook may be severely affected by coho in terms of growth rate and downstream displacement. In the North Thompson River (34, 35) large numbers of chinook juveniles immigrated into the mainstem in August from the Clearwater and other rivers and the mainstem was used extensively as a rearing area for fry, 90-day and older juveniles (48). However, chinook fry in the Raft River emigrated downstream into the North Thompson very quickly after emergence and migrated back in July and

August, suggesting that intra- and interspecific competition in the North Thompson forced fish into other habitats. Interspecific competition between coho and chinook juveniles was noted generally in rearing areas of the Nechako, Quesnel and Horsefly systems (8). In the Upper Fraser (44, 45) chinook juveniles were noted to be in schools and chinook smolts were frequently observed actively feeding on chinook fry in IPT boxes and sample buckets. Slim Creek fry (44, 45) had slower growth rates than fry in neighbouring Upper Fraser rivers; since the system was considered to be spawned at capacity, it was suggested that intraspecific competition and/or high summer temperatures had inhibited growth.

Bjornn (1971) suggested that photoperiod and growth may initiate physiological and behavioural changes; although seaward migrations were associated with changes in streamflow and temperature, he did not consider these to be causal factors. In the Upper Fraser study, outmigrations were associated with fish size and seemed to be initiated by temperature. Although there were differences in timing and temperature regime, there was no difference in photoperiod between the study streams (44, 45).

Chinook underyearling migrations and growth patterns may vary between streams and successive years of study. In the Quesnel River, chinook salmon were found to have five different stream-type scale patterns, indicating rearing in different areas and growth rates although not necessarily different life history patterns. Bowron and Willow chinook juveniles (21, 22) left the system from June to August so that a 90-day migration was postulated; however the majority of adults were classified as sub-2 from their scales.

The Fraser River mainstem is seen as a 'black box' with respect to the distribution and abundance of juvenile rearing. Juveniles may actively migrate out of the upper areas, only to settle out in rearing areas downstream. Chinook are felt to be opportunists in terms of the degree of freshwater rearing (this would explain the marked annual variation in sub-1/sub-2 proportions noted on adult scales, particularly in some upriver Fraser and Skeena stocks -- see Age section). Juveniles may hold in good rearing areas, then move on if that area becomes unsuitable physically due to changes in flow, temperature, competition or other factors.

A wide variety of habitat types were utilized by juvenile salmon (see Rearing Distribution section) and the patterns of system utilization varied. Tributaries were used in the Nechako (8), Stuart (13, 14) and Bowron Rivers, but not in the Willow (21, 22). Underyearling chinook reared in foreshore areas in Quesnel Lake (8), Slim and Tumuch Lakes (44, 45) and in Shuswap and Little Shuswap Lakes (38, 39) but Morice

Lake did not appear to be used extensively for rearing (56, 57). In all cases, chinook fry appeared to leave the foreshore in midsummer and downstream movements were presumed. Because juvenile chinook show a definite preference for stream margins (refer to Preferred Rearing Habitats section), their increased movement during discharge fluctuations, which was often noted in New Projects studies, was probably involuntary or forced.

1+ and 2+ Smolts:

At this stage, smolting physiology appears to be important, as well as life history strategies regarding age at maturation (see Length, Weight and Condition Factor section). In general, there were very low numbers of yearlings and older migrants captured, and biological cues to migration were difficult to judge. All studies associated migration of 1+ and 2+ juveniles with increasing temperature and discharge, but fish movements were not precisely correlated with either.

For the upper areas of the Fraser and Skeena Rivers, it is important to distinguish a smolt that is physiologically and behaviourally ready to accept introduction to saltwater, from a juvenile that is migrating to another freshwater area for rearing. The classic silvering response is temporally reversible for coho and steelhead when these species are retained in freshwater; they may undergo physiological changes that readapt them to the freshwater environment. In contrast to the other salmonids, chinook salmon acquire high salinity tolerance gradually while in freshwater without any sharp increase associated with a smolt transformation. Hoar (1976) points out that salmonids generally show a sharp increase in salinity tolerance during the springtime, developed prior to and independent of the smolt transformation. Active downstream migration from the upstream reaches may well occur long before physiological readiness for saltwater can be demonstrated.

Juvenile Length, Weight and Condition Factor

In preparing the data for between study comparisons, individual fish were categorized as emergent or rearing using the timing of peak catches. Consideration was also given to the capture technique used, as some methods (inclined plane traps and fyke nets) probably intercept migrants while others (minnow traps, seines, dipnet and electrofishing) tend to capture non-migrants. Each method, of course, has its own spectrum of biases. Daily average lengths and weights were then calculated according to the previous emergent or rearing classification, and condition factors were derived which were then averaged for the season. Although chum salmon were considered to be largely emergent fry, some probably were rearing fish; thus, condition factors for some stocks may be somewhat inaccurate.

There were two different condition factors that were calculated from length and weight data:

(1) $$Kd = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$$ Bams' development factor for emergent fry.

(2) $$K = \frac{100\ (\text{weight in mg})}{(\text{length in mm})^3}$$ Fulton's condition factor for rearing fry and fingerlings.

Equation (1) specifically describes emergent fish (Bams, 1970) during yolk absorption. Equation (2) assumes that fish shape does not change as it grows, so it is often used to describe differing condition factors between fish of similar lengths within a species. In this report, only emergent fry were described using the Bams' development factor; equation (2) was used for all other fish.

The following discussion compares juvenile length, weight and condition factor on a regional basis, to coordinate with adult age data in similar groupings. The regional data is biased, in that juvenile studies were conducted on only a few systems which may be more representative of a particular geographic zone than the regions per se (Tables 32 - 43).For example, South Coast chinook fry were obtained from five Tlupana Inlet tributaries (west coast of Vancouver Island) which have few climatic features in common with other study streams in the South Coast. Some of the Fraser River tributaries are geographically close to some of the North Coast streams (eg. Stuart River and Morice River) and encompass similar biogeoclimatic zones (Farley 1979). Broad statements about regional fish pulations thus may not be representative of fish in all streams of that gion.

Chinook (Tables 33 - 36):

There were significant differences between North Coast, South Coast and Fraser River fry, consistent with the adult age data described in Table 12. South Coast fry were longer and heavier than fry in other areas. Spawning chinook populations sampled in South Coast streams were classified as 60% sub-1, whereas North Coast and Fraser River chinook

Table 32. Statistical probabilities that the lengths, weights and condition factors of emergent salmon fry are the same for populations in the North, South and Fraser regions.

		Probability[a]			Probability[b]
Species	Parameter	North vs South	North vs Fraser	South vs Fraser	All Regions
CHINOOK	Length	.005	.100	<.001	<.001
	Weight	.029	NS[c]	.001	<.001
	Kd	NS	NS	NS	NS
COHO	Length	.003	.002	<.001	<.001
	Weight	NS	.002	<.001	<.001
	Kd	NS	NS	NS	NS
CHUM	Length	NS	----[d]	----	----
	Weight	NS	----	----	----
	Kd	NS	----	----	----
PINK	Length	.068	----	----	----
	Weight	NS	----	----	----
	Kd	NS	----	----	----
SOCKEYE	Length	----	----	NS	----
	Weight	----	----	NS	----
	Kd	----	----	.017	----

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[a] Given a Students' t-test for independent samples of population length, weight and condition factor, the probability that there is no difference between pairs of regions.

[b] Given a Kruskall-Wallis H-test, the probability that there is no difference between all three regions.

[c] Not significantly different (p>0.100).

[d] Insufficient data.

Table 33. Average lengths, weights and condition factors for juvenile CHINOOK salmon by region.

Age	Region	No. of Streams	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Condition Factor Kd
Emergent	North	7	39	0.46		1.955
Emergent	South	5	42	0.55		1.959
Emergent	Fraser	15	38	0.40		1.920
0+ rearing	North	1	57	1.86	1.102	
0+ rearing	South	1	76	4.70	1.079	
0+ rearing	Fraser	9	51	1.47	1.038	
1+ smolts	North	4	83	6.03	1.061	
1+ smolts	Fraser	18	83	6.68	1.065	

Table 34. Summary of mean length, weight and condition factor data for populations of emergent CHINOOK salmon during peak downstream migration.

Stream/Year	Sampling Period	n	Fork Length (mm)	Wet Weight (g)	Condition Factor Kd	Reference[a]
NORTH						
Morice/1979	Apr 27	50	39	0.52	2.046	56,57
Morice/1980	Apr 28	50	37	0.57	2.253	56,57
Kitimat/1980	Apr 9	16	40	0.43	1.911	11,12
Hirsch/1980	Apr 11	50	39	0.40	1.870	11,12
Cecil/1980	May 12	17	42	0.51	1.921	11,12
Kildala/1981	Mar 31	10	40	0.42	1.882	27,28
Dala/1981	Apr 2	5	39	0.34	1.799	27,28
SOUTH						
Sucwoa/1979	Apr 25	10	43	0.56	1.930	6
Canton/1979	May 1	29	41	0.54	1.972	6
Conuma/1979	May 14	20	41	0.51	1.930	6
Tlupana/1979	May 1	30	43	0.61	1.977	6
Deserted/1979	Apr 19	14	41	0.55	1.984	6
FRASER						
Bowron/1980	May 15	50	38	0.36	1.872	21,22
Willow/1980	May 22	48	38	0.38	1.906	21,22
Stuart/1980	May 11-18	50	38	0.39	1.938	13,14
Quesnel/1980	Apr 17	10	39	0.46	1.984	16,17
Eagle/1981	Apr 16	10	38	0.37	1.874	38,39
Salmon/1981	May 7	10	42	0.59	2.016	38,39
Adams/1981	May 3	10	40	0.46	1.940	38,39
South Thompson/1981	May 9	10	38	0.43	1.976	38,39
Blue/1981	Apr 3	10	37	0.32	1.839	34,35
Finn/1981	Apr 18	10	37	0.41	2.002	34,35
Raft/1981	Apr 22	10	38	0.39	1.948	34,35
Raft/1982	May 16	UK	38	0.40	1.940	48
Clearwater/1982	May 22	UK	38	0.28	1.720	48
North Thompson/1981	Apr 28	10	39	0.47	1.994	34,35
North Thompson/1982	May 22	UK	38	0.35	1.850	48

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[a] Reference document number (see Appendix A-1).

Table 35. Summary of mean length, weight and condition factor data for populations of age 0+ rearing CHINOOK salmon sampled during peak migration.

Stream/Year	Sampling Period	n	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Reference[a]
NORTH						
Kildala/1981	Jun 5-9	7	57	1.86	1.012	27,28
SOUTH						
Little Qualicum/1979	Jun 11-17	50	76	4.7	1.079	5
FRASER						
Bowron/1980	Jul 18	16	56	1.76	1.002	21,22
Willow/1980	Jul 17	58	57	1.93	1.042	21,22
Stuart/1980	Jun 12-19	59	49	1.15	.996	13,14
Quesnel/1979	Aug 2	10	56	2.06	1.186	8
Lion/1981	Jun 19-20	3	42	0.72	.993	34,35
Raft/1982	Jun 10	UK	43	0.78	.981	48
Clearwater/1982	Jul 20	UK	52	1.60	1.140	48
North Thompson/1981	Jun 11	10	45	0.97	1.060	34,35
North Thompson/1982	Jul 12	UK	62	2.25	.940	48

[a] Reference document number (see Appendix A-1).

Table 36. Summary of mean length, weight and condition factor data for populations of age 1+ CHINOOK salmon smolts during peak downstream migration.

Stream/Year	Sampling Period	n	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Reference[a]
NORTH						
Morice/1979	Apr 25-30	50	84	7.67	1.313	56,57
Kitimat/1980	Apr 26	5	86	6.30	0.990	11,12
Kildala/1981	Apr 26	6	81	4.98	0.940	27,28
Dala/1980	May 4	19	80	5.15	1.000	27,28
FRASER						
Holmes/1981	overall	UK	83	6.76	1.170	44,45
Morkill/1981	overall	UK	82	6.50	1.200	44,45
Torpy/1981	overall	UK	84	6.40	1.081	44,45
Slim/1981	overall	UK	81	6.00	1.132	44,45
Bowron/1980	May 13-17	26	75	UK	UK	21,22
Willow/1980	May 26-31	11	87	7.01	1.049	21,22
Stuart/1980	May 9-24	7	73	3.82	0.947	13,14
Quesnel/1980	Jun 14,17	7	113	13.50	0.931	16,17
Eagle/1981	May 22	4	88	7.63	1.087	38,39
Salmon/1981	overall		107	13.50	1.100	38,39
Lower Adams/1981	Apr 9	2	84	5.95	1.000	38,39
South Thompson/1981	Jul 10	7	89	7.70	1.086	38,39
Blue/1981	Apr 16-28	3	58	2.20	1.040	34,35
Finn/1981	overall	12	84	7.00	1.050	34,35
Clearwater/1982	overall	3	78	4.27	0.910	48
Lemieux/1982	overall	43	68	3.42	1.070	48
North Thompson/1981	Apr 20	60	84	6.34	1.054	34,35
North Thompson/1982	overall	99	78	5.56	1.190	48

[a] Reference document number (see Appendix A-1).

Table 37. Average lengths, weights and condition factors for juvenile COHO salmon by region.

Age	Region	No. of Streams	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Condition Factor Kd
Emergent	North	7	35	0.34		1.983
Emergent	South	8	36	0.36		1.959
Emergent	Fraser	10	33	0.33		1.941
1+ smolts	North	8	82	6.76	1.090	
1+ smolts	South	7	88	7.38	1.038	
1+ smolts	Fraser	15	79	5.45	1.031	
2+ smolts	North	6	102	12.42	1.074	

Table 38. Summary of mean length, weight and condition factor data for populations of emergent COHO salmon during peak downstream migration.

Stream/Year	Age	n	Fork Length (mm)	Wet Weight (g)	Condition Factor Kd	Reference[a]
NORTH						
Mathers/1979	0+	10	35	0.38	2.06	4
Kitimat/1980	0+	50	34	0.32	1.988	11,12
Hirsch/1980	0+	52	35	0.31	1.934	11,12
Cecil/1980	0+	42	36	0.34	1.966	11,12
Kildala/1981	0+	10	35	0.33	1.964	27,28
Dala/1981	0+	10	36	0.30	1.88	27,28
Bish/1981	0+	10	34	0.37	2.087	27,28
SOUTH						
Sucwoa/1979	0+	30	35	0.34	1.972	6
Canton/1979	0+	28	36	0.35	1.941	6
Conuma/1979	0+	29	36	0.32	1.916	6
Tlupana/1979	0+	26	38	0.40	1.939	6
Deserted/1979	0+	21	37	0.35	1.925	6
Little Qualicum/1979	0+	87	36	0.36	1.991	5
Glendale/1983	0+	24	37	0.39	1.987	67
Tom Browne/1983	0+	27	36	0.38	2.001	67
FRASER						
Quesnel/1980	0+	10	32	0.24	1.973	16,17
Eagle/1981	0+	10	35	0.34	1.988	38,39
Salmon/1981	0+	10	32	0.26	2.001	38,39
Adams/1981	0+	10	34	0.32	2.000	38,39
South Thompson/1981	0+	4	32	0.25	1.981	38,39
Blue/1981	0+	10	34	0.27	1.879	34,35
Finn/1981	0+	10	32	0.27	2.026	34,35
Lion/1981	0+	10	34	0.23	1.807	34,35
Raft/1981	0+	10	32	0.20	1.845	34,35
North Thompson/1981	0+	7	33	0.26	1.911	34,35

[a] Reference document number (see Appendix A-1).

Table 39. Summary of mean length, weight and condition factor data for populations of COHO salmon smolts during peak downstream migration.

Stream/Year	Age	n	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Reference[a]
NORTH						
Morice/1979	1+	15	95	10.96	1.286	56,57
Morice/1980	1+	27	107	14.75	1.218	56,57
Kitimat/1980	1+	28	84	5.79	0.963	11,12
Hirsch/1980	1+	2	62	2.58	1.093	11,12
Cecil/1980	1+	27	72	3.84	1.016	11,12
Kildala/1981	1+	10	90	7.66	1.065	27,28
Dala/1981	1+	10	78	4.67	1.000	27,28
Bish/1981	1+	12	72	3.89	1.075	27,28
Morice/1979	2+	2	124	24.57	1.289	56,57
Morice/1980	2+	16	110	15.13	1.152	56,57
Kitimat/1980	2+	6	87	6.37	0.974	11,12
Cecil/1980	2+	6	92	7.29	0.933	11,12
Dala/1981	2+	8	92	8.13	1.030	27,28
Kildala/1981	2+	4	107	13.01	1.065	27,28
SOUTH						
Sucwoa/1979	1+	UK	78	UK	UK	6
Canton/1979	1+	UK	86	UK	UK	6
Conuma/1979	1+	UK	85	UK	UK	6
Tlupana/1979	1+	UK	78	UK	UK	6
Deserted/1979	1+	UK	113	UK	UK	6
Little Qualicum/1979	1+	42	96	8.9	1.003	5
Glendale/1983	1+	14	79	5.86	1.072	67
FRASER						
Quesnel/1980	1+	17	100	8.90	0.890	16,17
Eagle/1981	1+	16	78	5.22	1.100	38,39
Salmon/1981	1+	20	89	6.81	0.979	38,39
Adams/1981	1+	20	79	4.78	0.959	38,39
Blue/1981	1+	13	58	2.08	1.050	34,34
Finn/1981	1+	6	63	2.95	1.169	34,35
Finn/1982	1+	9	79	UK	UK	48
Lion/1981	1+	22	79	5.33	1.085	34,35
Raft/1981	1+	25	76	4.11	0.936	34,35
Raft/1982	1+	4	80	5.38	1.050	48
Joseph/1982	1+	6	105	13.04	1.120	48
Lemieux/1982	1+	45	81	5.85	1.100	48
Barriere/1982	1+	8	71	3.34	0.930	48
North Thompson/1981	1+	6	85	6.45	1.039	34,35
North Thompson/1982	1+	2	59	2.06	1.030	34,35

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[a] Reference document number (see Appendix A-1).

Table 40. Average lengths, weights and condition factors for juvenile CHUM, PINK and SOCKEYE salmon by region.

Age	Species	Region	No. of Streams	Fork Length (mm)	Wet Weight (g)	Condition Factor K	Condition Factor Kd
Emergent	Chum	North	6	40	0.40		1.831
Emergent	Chum	South	8	40	0.41		1.861
Emergent	Pink	North	6	35	0.23		1.741
Emergent	Pink	South	6	34	0.21		1.726
Emergent	Sockeye	North	2	29	0.14		1.792
Emergent	Sockeye	South	5	28	0.13		1.779
Emergent	Sockeye	Fraser	3	30	0.24		2.034
1+ Smolts	Sockeye	North	2	87	6.67	0.990	
1+ Smolts	Sockeye	South	1	86	-	-	
1+ Smolts	Sockeye	Fraser	3	104	11.24	0.905	
2+ Smolts	Sockeye	North	2	120	17.32	1.001	

Table 41. Summary of mean length, weight and condition factor data for populations of juvenile CHUM salmon sampled during peak migration.

Stream/Year	Age	n	Fork Length (mm)	Wet Weight (g)	Condition Factor Kd	Reference[a]
NORTH						
Mathers/1979	0+	25	40	0.47	1.963	4
Kitimat/1980	0+	50	41	0.42	1.849	11,12
Hirsch/1980	0+	50	40	0.37	1.808	11,12
Kildala/1981	0+	10	40	0.37	1.786	27,28
Dala/1981	0+	10	41	0.42	1.840	27,28
Bish/1981	0+	10	41	0.36	1.739	27,28
SOUTH						
Sucwoa/1979	0+	20	42	0.44	1.820	6
Canton/1979	0+	30	41	0.44	1.860	6
Conuma/1979	0+	30	41	0.47	1.915	6
Tlupana/1979	0+	30	41	0.46	1.906	6
Deserted/1979	0+	29	39	0.44	1.930	6
Little Qualicum/1979	0+	241	39	0.36	1.835	5
Glendale/1983	0+	29	38	0.33	1.808	67
Tom Browne/1983	0+	19	38	0.34	1.823	67

[a] Reference document number (see Appendix A-1).

Table 42. Summary of mean length, weight and condition factor data for populations of juvenile PINK salmon sampled during peak migration.

Stream/Year	Age	n	Fork Length (mm)	Wet Weight (g)	Condition Factor Kd	Reference[a]
NORTH						
Mathers/1979	0+	25	36	0.28	1.849	4
Kitimat/1980	0+	40	34	0.24	1.810	11,12
Hirsch/1980	0+	50	36	0.25	1.765	11,12
Kildala/1981	0+	10	35	0.20	1.685	27,28
Dala/1981	0+	10	35	0.19	1.662	27,28
Bish/1981	0+	10	35	0.20	1.676	27,28
SOUTH						
Sucwoa/1979	0+	13	35	0.22	1.720	6
Canton/1979	0+	19	34	0.18	1.675	6
Conuma/1979	0+	7	34	0.19	1.706	6
Tlupana/1979	0+	4	35	0.23	1.751	6
Glendale/1983	0+	18	34	0.22	1.753	67
Tom Browne/1983	0+	25	34	0.22	1.748	67

[a] Reference document number (see Appendix A-1).

Table 43. Summary of mean length, weight and condition factor data for populations of juvenile SOCKEYE salmon during peak migration.

Stream/Year	Age	n	Fork Length (mm)	Wet Weight (g)	Condition Factor K(Kd)	Reference[a]
NORTH						
Kildala/1981	0+	5	29	0.16	1.847	27,28
Dala/1981	0+	5	28	0.12	1.737	27,28
Morice/1979	1+	12	85	6.37	(1.052)	56,57
Morice/1980	1+	86	90	6.97	(0.928)	56,57
Morice/1979	2+	4	119	18.03	(1.062)	56,57
Morice/1980	2+	10	121	16.60	(0.939)	56,57
SOUTH						
Sucwoa/1979	0+	30	29	0.13	1.747	6
Canton/1979	0+	30	29	0.13	1.741	6
Conuma/1979	0+	25	28	0.15	1.884	6
Tlupana/1979	0+	30	29	0.12	1.725	6
Deserted/1979	0+	30	26	0.14	1.797	6
Deserted/1979	1+	92	86	UK	UK	6
FRASER						
Quesnel/1980	0+	6	29	0.24	2.181	16,17
Eagle/1981	0+	UK	26	0.11	1.864	38,39
Salmon/1981	0+	UK	35	0.37	2.057	38,39
Quesnel/1980	1+	UK	93	7.32	(0.916)	16,17
Eagle/1981	1+	10	84	5.60	(0.962)	38,39
South Thompson/1981	1+	2	136	20.80	(0.836)	38,39

[a] Reference document number (see Appendix A-1).

spawners were 34% and 18% sub-1, respectively. Condition factors are very similar between all areas, despite clear differences between length and weight parameters (Table 32).

Size differences were less apparent for older juveniles, due in part to a lack of comparable data. It is noteworthy that Tlupana Inlet streams did not produce sub-2 juveniles (6) or adults (3).

Coho (Tables 37 to 39):

Similar to chinook, there were significant differences between emergent coho fry in the three regions (Table 32). Fraser River coho were significantly shorter and heavier than those in the North and South Coasts, although the condition factors for fry in all three regions were very similar.

Scale analysis was used to distinguish 1+ and 2+ juveniles in all studies. Table 39 indicates that 2+ juveniles were present only in the North Coast, which is not indicated by the adult scale data. It was estimated that while 15% of the North Coast spawners were sub-3 fish, 5% of the Fraser and 6% of the South Coast spawners were also aged sub-3. Although these proportions were small, there should have been some representation in the juvenile sampling. It is possible that trap selectivity or some other factor was acting against the capture of larger juveniles in some systems.

In the North Coast study streams, comparisons were made of the length, weight and condition factors between 1+ and 2+ smolts. T-tests for independent samples showed no significant differences between parameters of the two age groups. This indicates that a critical size may exist for coho smoltification, which is not necessarily reached by age 1+.

Chum, Pink and Sockeye (Tables 40 to 43):

Chum and pink were often target species and received considerable sampling effort, but no significant differences in fry quality were found. Sockeye fry in the Fraser River area had a significantly higher condition factor than fry in the South Coast. Comparisons of juvenile sockeye were not conducted due to a lack of data.

JUVENILE REARING

To establish that fish were rearing rather than migrating, it was necessary to capture and sample over a period of time in order to establish growth rates and distributions. Without repeated captures of marked individuals, it is possible that different populations have been sampled. Chinook, in particular, have been shown to shift habitat preferences with growth (Bjornn 1971) and the presence of different stocks and ages of migrant populations in large river systems (eg. mainstem Thompson River, mainstem Upper Fraser River) presents a considerable stock separation challenge. As much as possible, subjective notes have been incorporated into the text and tables to clarify stock specific details.

Rearing Distribution

In determining rearing distribution, three main points were established: the distribution of the fish in the watercourse, their relative abundance in certain areas, and whether the fish were rearing or transient. To establish physical distribution, traps (eg. minnow traps) were placed downstream of known spawning areas and various methods (eg. electroshocking) were used to capture or observe fish in areas thought to be secondarily important. Thus, representative sampling locations are critical to establishing fish distribution. In cases where areas were not sampled or where fish were not caught due to inappropriate gear, estimates of fish distribution may be skewed.

Relative abundance also requires some quantification of the sub-populations which was usually done by adjusting for catch per unit effort. Since this was difficult to accomplish with some gear types, most studies incorporated a mix of capture techniques that were judgementally blended by the consultant as a part of the field study in order to indicate distribution.

Freshwater Rearing:

Chinook and coho rearing was examined most intensively, especially in the interior Fraser. In most cases, the distribution of fish was river specific. The following generalizations were derived from the source documents, which are summarized in Appendix C-15 (Volume II).

Chinook salmon occupied a wide variety of changing habitats. Juveniles often were found rearing in the mainstem habitats of larger systems, especially in areas of slow flow. Sidechannels, debris dams in stream margins, backwaters and inside portions of meanders and undercut banks are examples of the kinds of river habitat that were often identified. Rearing in lake foreshore areas, such as Shuswap Lake

(38, 39), was also important to some stocks. Quesnel River studies in 1980 (16, 17) found that juveniles were largely absent from rearing areas that had been identified in 1979 (9). It was postulated that more extensive use of rearing habitats downstream of the study area were utilized, consistent with large catches of juveniles in the mainstem Quesnel River. In the North Thompson (34, 35, 48) both 0+ and 1+ fish were often found in the same habitat. The main question, with respect to chinook, was whether or not the individuals found were rearing, migrating or a combination of the two (see Cues to Migration).

Coho juveniles often were found along stream margins and frequently in pools. Similar to chinook, both 0+ and 1+ fish often were found at the same sites in North Thompson tributaries (34, 35, 48, 54) although 1+ fish generally were distributed further downstream. Coho were also found in lakes (eg. Little Shuswap Lake, 38, 39) as well as in swamp areas (eg. Peddie Creek, 54). In the North Thompson, coho were abundant in tributaries in August and were thought to overwinter there (54), although a mix of reared and emergent fish caught in the North Thompson indicated overwintering in the mainstem also (34, 35).

The rearing distributions of chum, pink and sockeye in freshwater usually were not addressed. Information on the rearing distribution of chum salmon in fresh water generally was not gathered, although some rearing was noted in Kitimat River tributaries (11, 12). Sockeye were assumed to be rearing in several large lakes (Quesnel, Bowron, Shuswap and Little Shuswap) as evidenced by catches of migrating juveniles near the outlets (16, 17, 22, 23, 38, 39). The mainstem North Thompson River evidently also contains rearing sockeye as 0+ fish were found rearing in the mainstem and 1+ fish were found in overwintering habitats in January (54). Sockeye (0+) were found rearing in the Salmon River and at the Bowron and Quesnel Lake outlets: the latter were thought to be migrants or lake strays. Freshwater rearing of pinks was not noted in any of the studies.

Estuarine Rearing:

Only the Kitimat and Kildala Arm studies (11, 12, 27, 28) addressed estuarine utilization by salmonids. The Kitimat and Kildala studies detailed estuarine rearing patterns for each species, based on set net and beach seine catches in tidal channels. The Tlupana Inlet study (6) gathered information on the seasonal abundance of zooplankton in nearshore environments but did not specifically describe estuarine rearing.

It was observed that chinook salmon migrated directly to the sea as emergent fry in the Tlupana Inlet study (6). In the other studies, there was evidence of multiple chinook life history patterns: both emergent and 90-day fry utilized the Kitimat estuary in turn. Very few chinook fry remained in the estuary past August; after four months of estuarine growth, the 0+ fry were larger than the 1+ fish had been after a year of freshwater residence (11, 12). Chinook fry were also found in inshore areas, away from the estuaries. Chinook 1+ smolts did not appear to use the estuaries for rearing.

Coho fry also were observed to migrate seawards in the Tlupana Inlet streams. In the other systems, coho fry made extensive use of the estuaries and were present through July. They were found in nearly all areas and showed significant growth. Some were noted to be searching for freshwater sources along the fringes and were felt to be habitat limited and possibly in competition with chinook fry. Very few 1+ smolts were captured in the Tlupana Inlet streams and it was felt that stream rearing was a limiting factor, although flooding may also have been a factor in flushing emergent fry of several species from the watercourses. Coho 1+ smolts, similar to chinook 1+ smolts, were highly transient.

Chum fry used Kitimat, Kildala and Bish estuaries extensively and downstream trap capture peaks did not coincide with river outmigrations, suggesting some immigration from other marine rearing areas. However, chum residence appeared to be short (days to weeks); growth was not significant among residents in the Dala and Kildala estuaries, although growth was clearly noted in the Kitimat and Bish estuaries.

Small numbers of sockeye fry used the Kitimat estuary in areas of heavy freshwater influence, and showed considerable growth. The few pink fry recovered were considered to be actively outmigrating.

Fish Density

Maximum densities for chinook salmon juveniles in natural stream environments ranged from 0.012 to 0.610 (average 0.142) fry/m^2 while coho densities were higher, ranging from 0.015 to 2.06 (average 0.411) fry/m^2 (Tables 44 and 45). These densities appear to be lower than other values in the literature, although there are no data directly comparable for interior Fraser tributaries.

Even though coho densities were calculated during summer low flows when fish density would appear to be highest, all values appeared relatively low, except for Barriere and Seymour densities. Coho smolt densities in coastal systems have been recorded from 0.41 to 1.41

Table 44. Juvenile chinook densities in preferred stream rearing areas.

Stream/Study Year (Reference No.)	Habitat Type	Age	Fish/m^2
Stuart/1980 (13,14)	highest fry densities occurred in areas of gently sloping or level substrate with slow to moderately flowing current (mainstream)	0+	max = 0.012
Bessette/1983 (62,63)	primary rearing locations were situated in relatively deep pool/glide habitats with low velocity and good cover. Gravel substrate preferred.	unknown	0.18 - 0.61
Finn/1982 (48)	suitable flows typically consisted of riffles, with gravel/cobble substrate and overhanging vegetation preferred habitats.	0+	0 - 0.025
Raft/1982 (48)	gradient moderate, flow velocity moderate, flow character run/riffle/pool. Gravel/sand substrate and cutbanks and log debris also preferred.	0+	0 - 0.036
Clearwater/1982 (48)	Cobble/boulder preferred substrate, with overhanging vegetation and log debris.	0+	0 - 0.028
	OVERALL MAXIMUM DENSITY		0.142 (n=5)

Table 45. Juvenile coho densities in preferred stream rearing areas.

Stream/Study Year (Reference No.)	Habitat Type	Age	Fish/m^2
Seymour/1982 (49)	along shore margins; large gravel substrate; overstream vegetation	0+ and 1+	≤0.8
McNomee/1982 (49)	low velocity pool and glide areas associated with complex log cover; large gravel substrate. Cover primarily log debris.	0+ and 1+	≤0.54
Finn/1982 (48)	lower flow velocities and good cover, especially in sidechannels; gravel/cobble substrate; log debris, abundant bank vegetation.	0+ and 1+	≤.025
Clearwater/1982 (48)	margin areas where flow was slow; boulder/bedrock substrate; no cover present.	1+	≤.006
Dunn/1982 (48)	backeddies containing organic debris; the section as a whole exhibits a riffle/glide flow character; gravel substrate; limited overstream vegetation	0+ and 1+	≤.02 (fry)
McTaggart/1982 (48)	riffle/pool flow along meanders; gravel/sand substrate; extensive canopy, instream debris.	0+	.015 - .058
Lemieux/1983 (48)	sidechannels and backwaters in association with log debris;gravel/cobble substrate; undercut banks and log debris.	0+ 1+	.003 - .173 ≤.013
Barriere/1982 (48)	many sidechannels and backeddies; turbid; flow is swift through a deep, main channel; cobble substrate; bank vegetation extensive; aquatic vegetation; cobble substrate.	0+	1.17 - 2.06
	OVERALL MAXIMUM DENSITY		0.411 (n=9)

smolts/m^2 (Armstrong and Argue 1977) in the Cowichan system and at 0.19 smolts/m^2 in the Big Qualicum (Lister and Walker 1966). Tripp and McCart (1983) conducted experimental outplanting of coho salmon in southern Vancouver Island streams: planting densities of 0.36 - 1.79 fish/m^2 (averaging 0.71 during the peak planting time from mid-July to mid-October) dropped to 0.22 fish/m^2 by October 31.

Similarly, chinook salmon densities were much lower than those recorded in the literature. In Idaho, Bjornn (1978) recorded 0.59 - 1.3 fish/m^2 and Lister and Genoe (1970) recorded 1.22 fish/m^2 in the Big Qualicum.

The most obvious explanation for this disparity is that the studies were directed towards those systems that were thought to have underutilized rearing areas, in anticipation of implementing hatchery outplanting of coho and chinook juveniles. The New Projects data in Tables 44 and 45 and in Appendix C-17 (Volume II) were selected to be representative of preferred rearing areas. It thus appears that scarcity of individuals was a result of underseeding rather than unsuitable habitat.

The density of chinook salmon rearing in streams was considerably lower than the density of coho salmon. Although there may be some disparity in capture and shocking techniques, whereby the larger river systems inhabited by chinook salmon are less effectively sampled, there may also be an ecological significance (see Cues to Migration).

PHYSICAL HABITAT CHARACTERISTICS

Although there were large amounts of data collected in the New Projects studies describing the physical characteristics of salmon spawning streams, it was not approached consistently. Study purposes also changed, from simple physical listings with little biological interpretation, to actual versus potential spawning and rearing capabilities. Data collection was also extremely inconsistent, both as to the number and type of habitat parameters recorded as well as the manner in which the numbers were derived. The New Projects Unit attempted to minimize such inconsistencies by specifying use of standards developed by the B.C. Ministry of Environment Resource Assessment Branch (Chamberlin 1980) as soon as they became generally available. Several of the earlier studies, such as the Kakweiken fishway study (31, 32), relied largely on subjective descriptions of important habitat features. By the 1982 study year, all physical characteristics were standardized using De Leeuw's (MS1981) inventory method.

Of those studies where spawning habitats were described in well-defined, quantitative terms, most recorded temperature, substrate size and water depth; only a few studies reported velocity and gradient. These characteristics were often referred to in more subjective terms which adequately described the spawning or rearing area for that particular study, but which were not useful for comparative purposes.

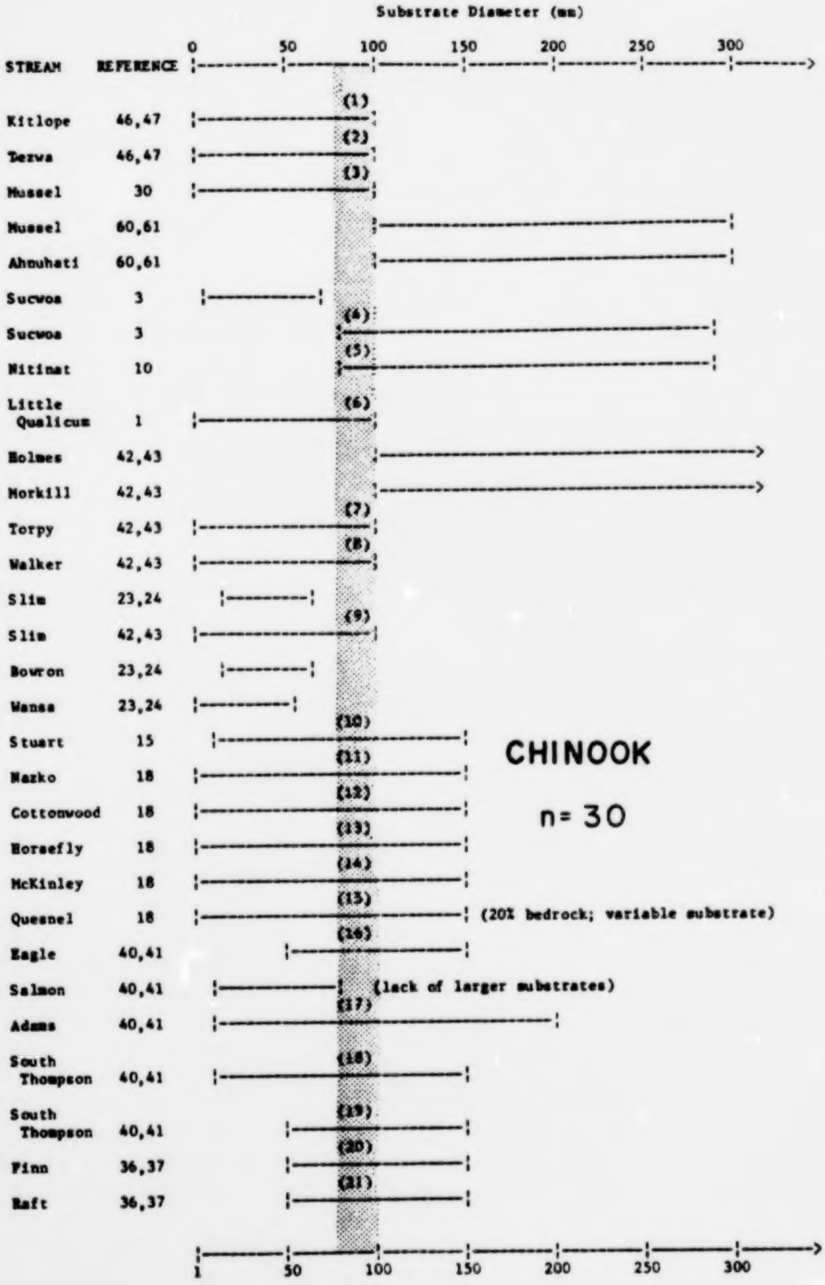
Furthermore, there was considerable variability in the manner in which these factors were measured. Temperature could be either a spot check or range calculation from a thermograph. Substrate size was most inconsistent in that definitions (fines, sand, small and large gravel, cobble and boulder) varied considerably. Gravel was considered as substrate with diameters ranging up to 15 cm. Depth, velocity and gradient were more easily quantified, although velocity (meter or drifting leaf method) may refer to surface velocity rather than velocity over the redd.

This section compares the habitat utilization information gathered in this series of studies with that assembled by Bovee and Cochnauer (1977) and Bovee (1978). In the latter study, preferred habitat conditions for different species and life stages are expressed as "probability-of-use" curves about an optimum range and the following assumptions were made:

1. that fish select for certain habitat conditions;
2. that fish will use less favourable habitats; and,
3. that fish will not be present if conditions are lethal.

Using those assumptions, we have organized the New Projects data from Appendices C-16 and C-17 (Volume II) into a similar format to indicate the habitat preferences of B.C. salmon. Frequency distributions were developed on the New Projects data by extending lines across a continuum, determining frequency by making vertical counts (Figure 14) and developing histograms for each species. Probability-of-use curves from the Bovee (1978) studies were then overlaid on the New Projects graphs for comparison. For purposes of comparison in the text, preferred ranges were developed from the Bovee curves where probability of use exceeded 50%.

The analyses are not strictly identical, due to differing objectives. The work of Bovee and Cochnauer (1977) was developed to assess the impacts of altered streamflow regimes in stream habitat. Those parameters which are most closely related to stream hydraulics (depth, velocity, substrate and temperature) were examined for several species and life stages. The New Projects studies gathered baseline biological information to develop enhancement strategies for major facilities' requirements and performance (eg. egg availability).



Diameter (mm)	Count
< 5	13
5 - 9	14
10 - 14	18
15 - 49	20
50 - 64	24
65 - 79	19
80 - 99	21
100 - 149	18
150 - 199	7
200 - 290	6
> 290	4

Figure 14. Sample calculation of frequency distribution for habitat preference data in New Projects studies (substrate diameter found in chinook spawning areas).

Accordingly, the New Projects data have been treated differently than what Bovee and Cochnauer suggested for this kind of analysis. Most importantly, our information was based on frequency of observations for fish populations, rather than for individual fish. This has resulted in some over-representation of interior chinook and late run coho stocks, which may affect the shape of the curves. Furthermore, given the wide range of geography, climatic conditions and type of study, statistically significant optima were difficult to define and thus the data have been left in the form of frequency distributions. Only quantified measurements of the various habitat parameters were used in this analysis. The data sources that were used to derive each of the summary tables and figures are listed in Tables 46 - 50.

SPAWNING HABITAT

Substrate size, temperature, depth and velocity data are compared by species below. All the data were derived from Appendix C-16 (Volume II) which identifies stream habitat characteristics as they correspond to known spawning populations. Using Bovee and Cochnauer's (1977) criteria, excellent data would comprise at least 200 individual parameters and X^2 tests of optimum showing significant difference between frequencies ($p<0.10$). The quality of the New Projects data is conservatively rated as fair, indicating that the frequency analysis was conducted with less than 50 measurements, under a limited range of hydraulic conditions, and there is a large variance within the optimum range (X^2 tests to establish optima are not done).

Substrate

Coho appeared to tolerate a larger proportion of fine bed materials and less cobble and boulders. Sockeye tended to orient towards larger substrate:

No. of Streams	Species	Percent of Substrate in Spawning Areas		
		Fines	Gravel	Cobble and Boulder
32	Chinook	14	60	26
11	Coho	25	56	19
14	Chum	12	65	23
7	Sockeye	11	43	46
14	Pink	18	58	24

Table 46. Data sources for physical characteristics of preferred spawning and rearing habitats of CHINOOK salmon.

Reference[a]	Substrate Size/Type	Water Velocity	Water Depth	Water Temperature
SPAWNING				
1	X			
3	X			
9				X
10	X	X	X	X
15	X	X	X	X
18	X		X	X
23,24	X			
30	X		X	X
36,37	X		X	X
40,41	X		X	X
42,43	X		X	X
46,47	X	X	X	X
60,61	X	X	X	X
N[b]	30	5	28	28
REARING				
8	X	X	X	
13,14		X	X	
16,17	X	X	X	
36,37	X		X	
38,39	X	X	X	
44,45	X	X		
48	X			
49	X	X		
57	X	X		
62,63	X	X		
N[b]	28	13	15	

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[a] Reference document number (see Appendix A-1).

[b] Total number of streams included in frequency analyses.

Table 47. Data sources for physical characteristics of preferred spawning and rearing habitats of COHO salmon.

Reference[a]	Substrate Size/Type	Water Velocity	Water Depth	Water Temperature
SPAWNING				
2	X		X	X
50,51	X	X	X	X
54	X	X	X	X
60,61	X	X	X	X
N[b]	10	9	13	13
REARING				
9	X	X	X	
11,12		X		
16,17	X	X	X	
36,37	X	X	X	
38,39	X	X	X	
48	X	X		
49	X	X	X	
54	X	X	X	
62,63	X			
64,65		X	X	
N[b]	32	16	14	

[a] Reference document number (see Appendix A-1).

[b] Total number of streams included in frequency analyses.

Table 48. Data sources for physical characteristics of preferred spawning and rearing habitats of CHUM salmon.

Reference[a]	Substrate Size/Type	Water Velocity	Water Depth	Water Temperature
SPAWNING				
1	X			X
2	X		X	X
3		X	X	X
19,20	X			X
30			X	X
31,32	X			X
46,47	X		X	X
60,61	X	X	X	X
64,65	X			X
N[b]	14	7	11	20
REARING				
		None		

---

[a] Reference document number (see Appendix A-1).

[b] Total number of streams included in frequency analyses.

Table 49. Data sources for physical characteristics of preferred spawning and rearing habitats of PINK salmon.

Reference[a]	Substrate Size/Type	Water Velocity	Water Depth	Water Temperature
SPAWNING				
2	X			X
30	X			X
40,41			X	X
60,61	X	X	X	X
64,65	X			X
N[b]	14	5	6	12
REARING				
		None		

---

[a] Reference document number (see Appendix A-1).

[b] Total number of streams included in frequency analyses.

Table 50. Data sources for physical characteristics of preferred spawning and rearing habitats of SOCKEYE salmon.

Reference[a]	Substrate Size/Type	Water Velocity	Water Depth	Water Temperature
SPAWNING				
31,32				X
36,37			X	X
40,41			X	X
46,47	X			X
60,61	X	X	X	X
64,64	X			X
N[b]	4	Omitted	4	7
REARING				
16,17	X	X	X	
36,37	X	X	X	
38,39	X	X	X	
48	X			
N[b]	7	4	5	

---

[a] Reference document number (see Appendix A-1).

[b] Total number of streams included in frequency analyses.

These data must be qualified by noting considerable size overlaps in the definitions of substrate type. These varied between studies, particularly between "gravel" and "cobble" substrate:

Substrate Type	Range in Sizes as defined in the various studies
Fines	0 - 10 mm
Gravel	>1 - 150 mm
Cobble	64 - 300 mm
Boulder	>64 - >300 mm

Bovee (1978) indicated that chinook, coho and sockeye prefer to spawn in gravel. Although in his study, intermediate code values referred to a percentage mixture, not a size gradation, preferred spawning substrate for chinook salmon had higher proportions of cobble/rubble (code 6) rather than entirely gravel (code 5) (see also REARING HABITAT: Substrate Size). Preferred substrate type was 5.4 for spring chinook ($p>0.5$ from 4.9 - 5.6) and 5.3 for fall chinook ($p>0.5$ from 4.9 - 5.5), determined from data on Oregon streams. Interspecific differences were also apparent when New Projects data were organized by substrate size rather than type. Weighted average substrate sizes were calculated for each stream, year and species, based on proportions per stated size range. However, the table below is biased towards those studies that did not indicate a maximum substrate size. When some of the sockeye data are rejected to reduce this bias (Tezwa and Kalitan Rivers, 1981: 80% of preferred sockeye spawning substrate was > 100 mm diameter; 46, 47), the average preferred substrate diameter is higher for chinook and lower for pink than for the other species:

N	Species	Average Diameter (mm)	± 2 S.E.	Bovee (1978)
32	Chinook	94	22	5.4[a], 5.2[b]
7	Sockeye	132	67	5.0[c]
5	Sockeye (adjusted)	84	40	
14	Chum	76	19	no data
11	Coho	59	15	5.0
14	Pink	17	6	no data

[a] Spring chinook
[b] Fall chinook
[c] All areas

The New Projects data are presented as frequency distributions (Figure 15). For each stream, only the substrate size range that composed the largest proportion of the spawning habitat was used to develop the frequency distributions; smaller proportions of certain substrate sizes are ignored in this figure. The tendency of pink salmon to select smaller-sized substrate is again illustrated here, even though these data are biased upward using the majority range method described above. On most occasions when pink salmon were intensively studied (31, 32, 60, 61), the populations were large enough to be spawning in suboptimal conditions, usually over larger gravel or cobble. As indicated earlier, chinook salmon appear to prefer larger gravel (approximately 80 to 100 cm). Coho and sockeye size preferences are less clear-cut, due to a lack of data and perhaps species selectivity for some other parameters. Chum salmon appear to prefer substrate sizes intermediate to the other species.

Water Temperature

Water temperature data were averaged from mean temperatures for each stream and species during the spawning period. To describe temperature ranges, the degree range (where given) was also averaged. Data not specifically associated with spawning as well as all spot temperatures were omitted:

No. of Streams	Species	Mean °C	± 2 S.E.	Mean Range °C	± 2 S.E.
25	Chinook	13.0	0.7	6.6	1.4
12	Coho	4.5	1.7	3.4	1.4
20	Chum	10.0	0.9	5.8	1.4
7	Sockeye	11.1	1.9	4.6	1.7
11	Pink	10.4	0.9	9.4	1.7

Chum, pink and sockeye spawned at approximately 10 - 11°C. Chinook spawned in relatively warmer water (13°C) and coho in colder water (<5°C). Timing was clearly a factor in determining coho spawning conditions as the major stocks studied were later, upriver runs (36, 37, 40, 41, 50, 51, 54). Similarly, the majority of chinook temperature data was derived from interior Fraser studies which were selected for their early immigration timing (9, 15, 18, 23, 24, 36, 37, 40, 41, 42, 43).

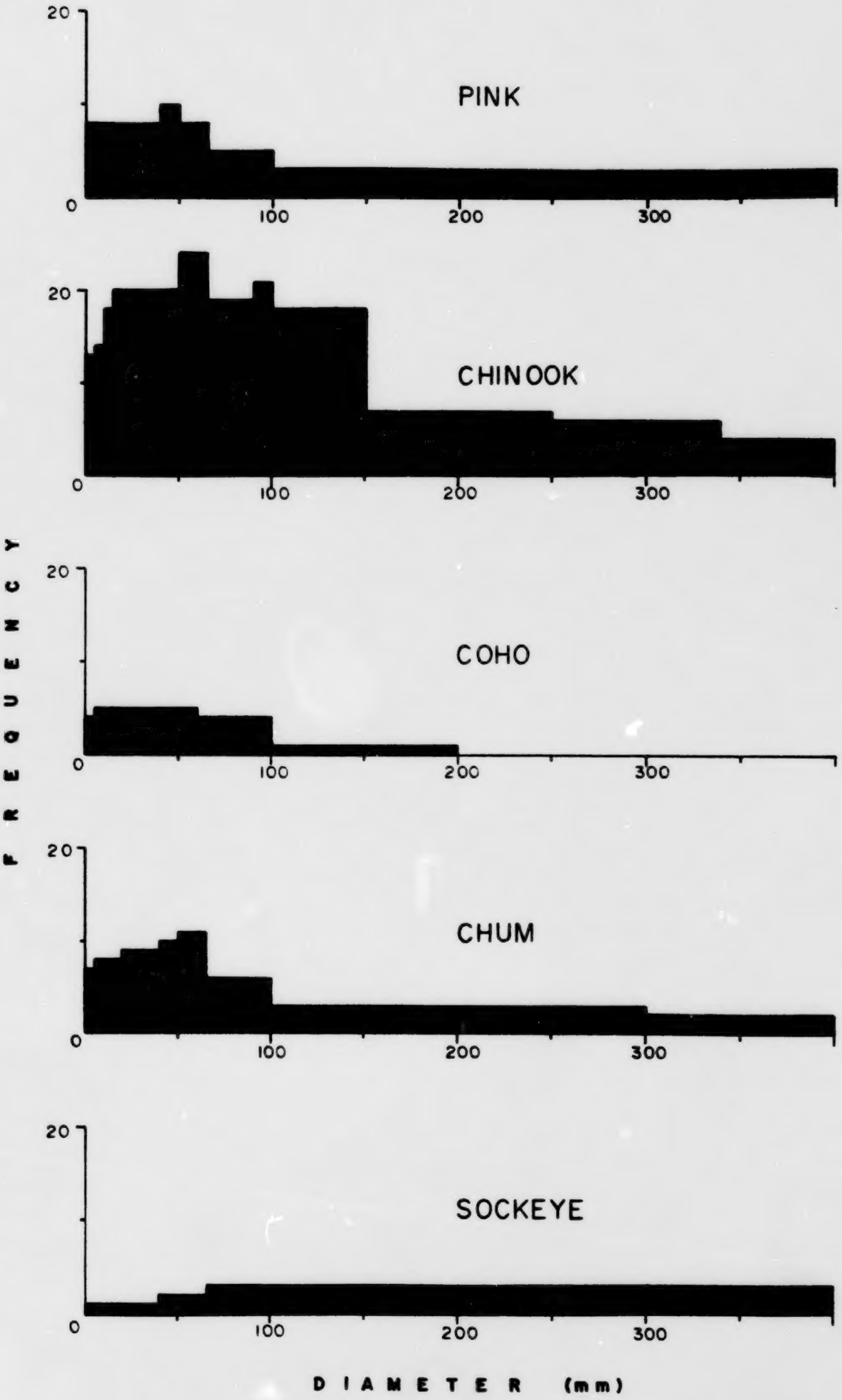

Figure 15. Dominant substrate sizes of preferred spawning habitats (see Tables 46 - 50 for details of data base).

There appear to be stock specific differences in water temperature at spawning, which may reflect spawning timing or overall habitat selection rather than preferred water temperatures. New Projects data frequency distributions are compared (Figure 16) with probability-of-use curves from Bovee (1978). Bovee's data identify water temperatures for spring (warmer) and fall (cooler) chinook at spawning. The New Projects chinook data appeared to be closer to Bovee's spring-run pattern than to his fall-run pattern, consistent with the early migration timing of Fraser River stocks. For sockeye spawning habitats, water temperatures were considerably colder in the Bovee data ($p>0.05$ from 0.8 to 7.7°C) than was observed in the New Projects studies (mean 11°C). Sockeye runs in the New Projects studies were mostly minor stocks, so that data may not be characteristic of this species as a whole. Bovee's data were also based on only a few stocks, so that if specific habitat preferences were different from those studied in the New Projects group (eg. data from glacial-fed lake tributaries would likely reflect a lower overall spawning temperature) the data may not be comparable. Earlier in this report (see SPAWNING POPULATIONS: Timing, Distribution) more detailed descriptions were provided on factors which may influence distribution of spawning populations and their seasonal timing.

The maximum observed spawning temperatures in the New Projects studies were less than those considered to be physiologically limiting. Brett (1956) observed that the physiological maximum for Pacific salmon juveniles was approximately 25°C, higher than anything recorded in these studies. Chinook spawned in temperatures up to 21°C in the South Thompson River (40, 41). Pink salmon in Glendale River spawned in 21.5°C water (60, 61). In nature, other complexing factors such as crowding (by increasing oxygen consumption with reduced dissolved oxygen availability), accelerated growth of disease organisms (eg. furunculosis), various temperature-dependent toxicities and behavioural changes that promote holding rather than spawning, tend to obscure the causes of prespawning mortality although death may in fact result from temperature-related stress. Over 21% of the female carcasses in Slim Creek were unspawned and were thought to result from a combination of thermal stress ($T > 15$°C) and parasites (42, 43). Chinook carcasses recovered in the Raft River (36, 37) contained relatively high proportions of partly-spent females, which coincided with sustained high water temperatures around 18°C. The Nechako River chinook population had 22% prespawning mortality, presumably related to physiological duress in a year of low discharge, although temperatures in the prime spawning areas were in the optimum range (12.5 - 15°C; 9).

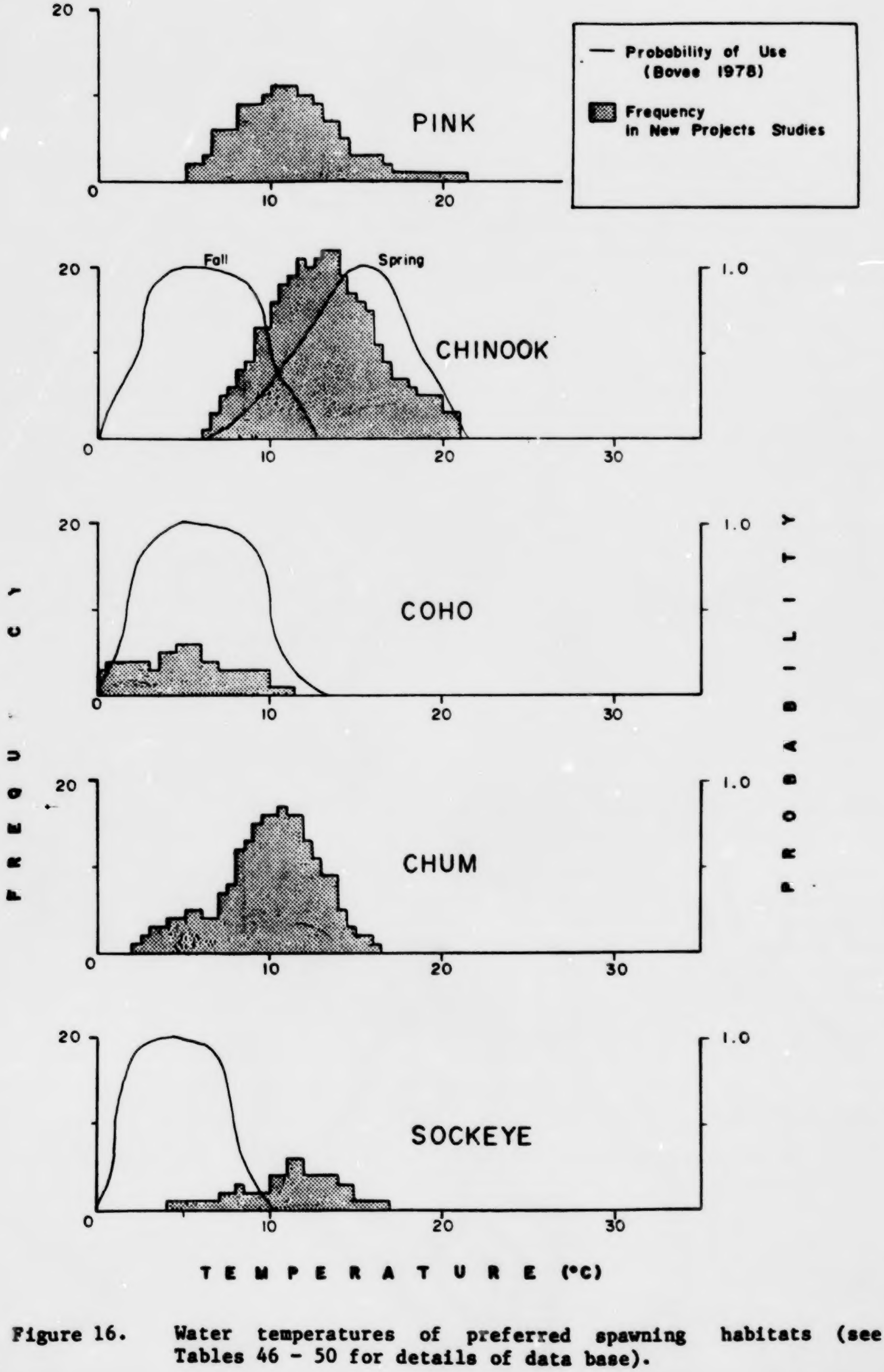

Figure 16. Water temperatures of preferred spawning habitats (see Tables 46 - 50 for details of data base).

The maximum temperatures recorded for chum, sockeye and coho were well below the 25°C maximum indicated by Brett (1956). Chum spawned in temperatures as high as 16.5°C in the Quatlena River (64, 65) and 16°C in Deserted Creek (3). Both of these prime spawning areas were noted to be within tidal influence, which may have had some effect on ambient water temperatures. The highest recorded spawning temperatures for sockeye in the New Projects studies were 17°C in the South Thompson River (40, 41) and 15°C in the Kakweiken (31, 32) and Raft (3, 37) Rivers. Maximum spawning temperatures recorded for coho were 11.5°C in Mathers Creek (2), and 10°C in Mussel (60, 61) and Lion (54) Creeks. For coho, physiological limits may be approached because of low temperatures: Salmon (40, 41), Lemieux (54) and Coldwater (40, 41) populations spawned at temperatures as low as 0°C. Brett (1956) stated that the freezing point of body fluids in teleosts is -0.5 to 0.9°C.

Water Depth

In the New Projects studies, all species except chum had spawned over wide depth ranges (Figure 17). Chinook were found most often between 40 and 200 cm (much deeper than Bovee's $p>0.5$ from 15 - 35 cm) over a wide variety of river conditions (see SPAWNING POPULATIONS: Distribution). Coho spawned in the Lower Adams at approximately 4 m depth (40, 41), although they were most often found at about 50 cm, again higher than Bovee's prediction of 20 to 40 cm. Sockeye and pink salmon data were insufficient to identify a clear mode, although both species were found primarily in depths of 100 cm or less. This is consistent with Bovee's prediction of a high probability of use between 23 and 53 cm for sockeye. Chum and pink salmon were recorded spawning in relatively shallow water of 100 cm or less (Bovee did not generate curves for chum or pink salmon).

Some of the data for preferred spawning habitats in the South Thompson River described mean depths of a certain reach, rather than mean depths of the spawning areas (Appendix C-16, Volume II). In this study (40, 41), pink salmon spawned in reaches approximately 5 m deep, sockeye were observed spawning at depths up to 7 m and chinook may have spawned even deeper (M.A. Whelan, E.V.S. Consultants, Vancouver, pers. comm.). Due to the size and depth of the river, it was not practical to determine preferred depth more accurately .

Water Velocity

In New Projects studies, chinook and coho spawned in faster water

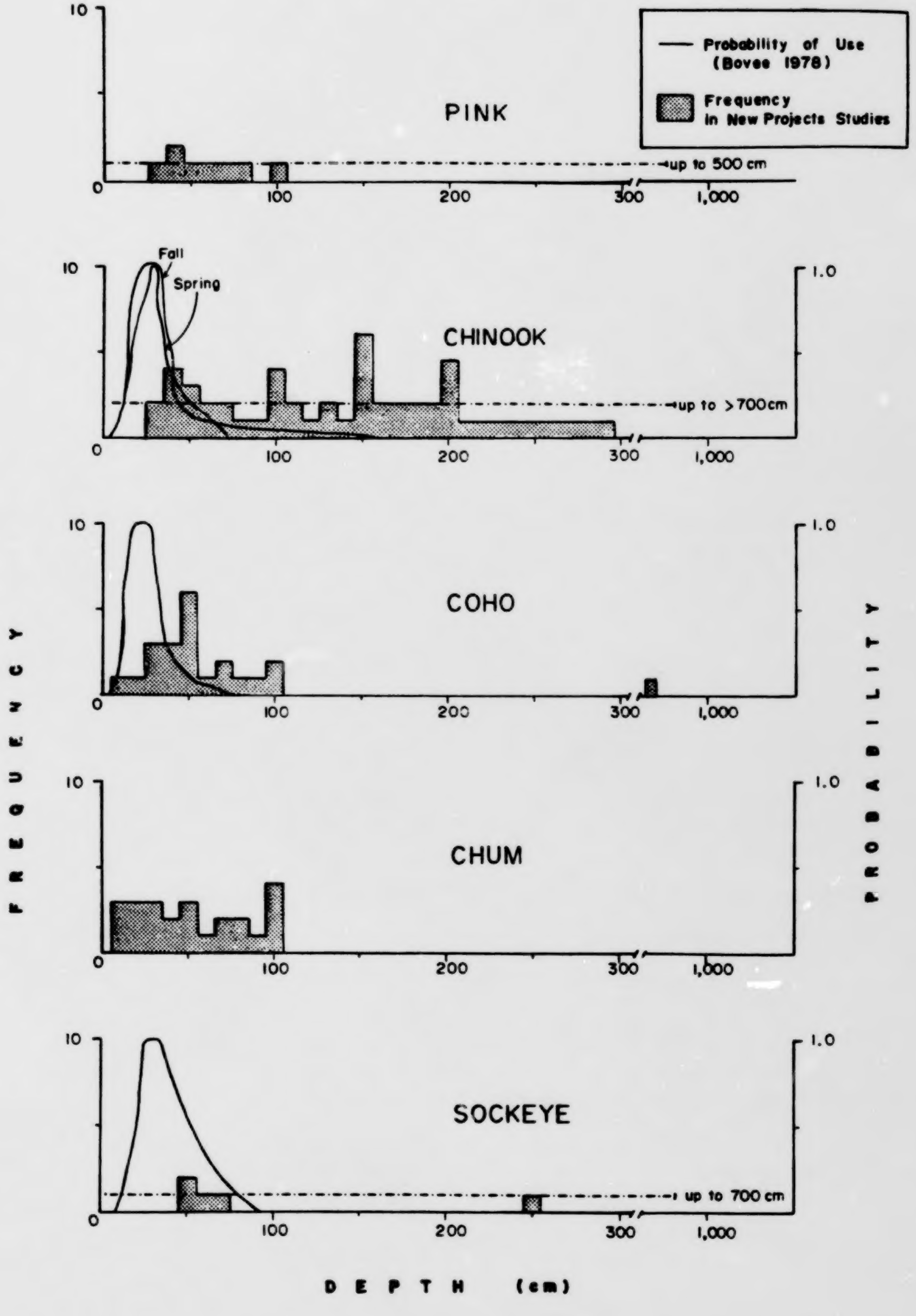

Figure 17. Water depths of preferred spawning habitats (see Tables 46 - 50 for details of data base).

(approximately 100 cm/sec and 70 cm/sec, respectively) than the other species (approximately 50 cm/sec; Figure 18). These chinook data disagree with Bovee's estimate for $p>0.5$ of 20 and 70 cm/sec. His predictions for coho were slightly closer, but still lower at 25 - 60 cm/sec. Only one data point was obtained for sockeye (Mussel Creek, 1983; 100 cm/sec surface velocity; 60, 61), which again was higher than the 30 - 60 cm/sec. expected from the Bovee curve.

Most of the velocity data collected in the New Projects studies related to surface velocity rather than mean velocity. Bovee's data were obtained by measuring the mean velocity at 0.6 of the depth from the surface if the water was less than 90 cm deep, or by averaging measurements at 0.2 and 0.8 of the depth in deeper water. Since the maximum velocity of flow in the water column occurs at a point slightly below the surface (Arsenault 1976), surface velocity measurements are often multiplied by 0.8 (rough bottom) or 0.9 (smooth bottom) to obtain the true water column mean (Orth, 1983). Applying those multipliers to the New Projects data, chinook velocity estimates still would be higher than Bovee's estimates, although the other species approximately coincide.

REARING HABITAT

Values for depth, velocity and fry density were derived from sampling methods that varied considerably between and within New Projects studies. In addition, these values were developed as an average or mode of conditions for a stream section or reach, rather than on a microhabitat basis. Physical characteristics of preferred rearing habitats, consisting mostly of subjective descriptions of macrohabitat, are listed in Appendix C-17, Volume II). Only chinook, coho and sockeye juveniles are addressed here, as chum salmon were rarely observed rearing in freshwater and pink salmon not at all (see Rearing Distribution).

Physical characteristics of preferred chinook and coho rearing areas were measured and described mostly in Fraser River tributaries. In particular, studies in the North and South Thompson drainages (34, 35, 38, 39, 48) provided most of the following quantitative information. Chum and sockeye were not examined in any detail, and pink fry were not found rearing in freshwater in any of the studies. In addition, there were three studies undertaken on Thompson River streams with rearing habitat description and quantification as specific objectives:

1. In the North Thompson River (54), late summer rearing areas were identified. In the winter, minnow-trapping continued, including sampling for length, weight and eye

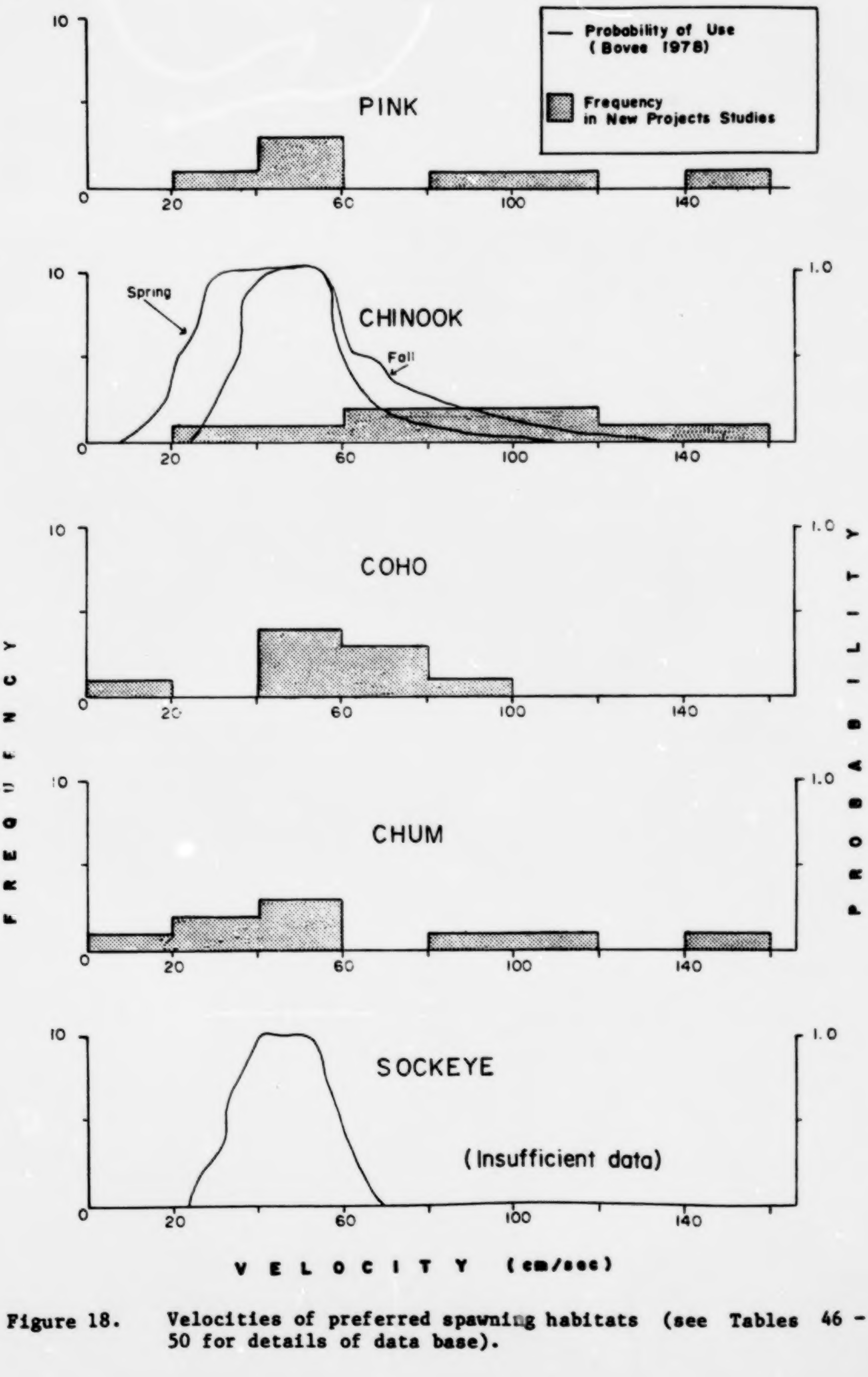

Figure 18. Velocities of preferred spawning habitats (see Tables 46 - 50 for details of data base).

Cont'd. diameter (as an index of age). The study described productive areas in terms of reaches. The intention of the program was to generate information useful to DFO for wild stock coho management purposes.

2. Six tributaries of the South Thompson River (49a, b) were examined for chinook and coho fry outplanting opportunities in areas thought to be underutilized. The program focussed on providing late summer standing crop estimates for juvenile salmonids. Using probability-of-use curves (Bovee 1978), theoretically good surplus habitat was identified.

3. The Middle Shuswap River (62, 63) was the subject of an assessment of juvenile salmonid habitat quality and quantity at different flows. Habitat assessments in terms of "habitat units" (De Leeuw MS 1981; Tredger 1980) were used to describe accessible and inaccessible stream areas and their use by fish in late July and again in late September.

All three studies recognized the theoretical nature of estimated rearing potential, due to uncertainties in life history patterns and annual variations in habitat.

The quality of the New Projects data is fair for water depth and at the reconnaissance level for the more subjective graphs on substrate and velocity (ie, rated parameters rather than quantitative: see Bovee 1978). Data for substrate type, temperature, depth and velocity of prime rearing habitats should be approached with caution.

Substrate Size

In most cases, the field data described only substrate type rather than a particular size range, so subjective notes on predominant substrates were incorporated into a coded scale, as suggested by Bovee and Cochnauer (1977):

Substrate Class	Description
1	Plant detritus
2	Mud
3	Silt
4	Sand
5	Gravel
6	Rubble
7	Boulder
8	Bedrock

Mixtures of two different (but adjacent) substrate types were described by their numeric average: non-adjacent values (boulders/mud) were given half values for each datum. For example, substrate described as a gravel/rubble mix was given a frequency of 1 at substrate class 5.5. Substrate described as a bedrock/mud mix was given a frequency of 0.5 at substrate class 2, as well as 0.5 at substrate class 8.

Gravel was the preferred substrate for rearing juvenile chinook, coho and sockeye (Figure 19). There was no apparent difference in substrate preference between 0+ and 1+ juveniles for any of these species. Bovee (1978) also showed a preference for gravel substrate by chinook and coho fry; however, the New Projects studies indicated chinook preferences to be skewed more towards smaller substrates than shown by Bovee.

Water Temperature

Water temperature data were not a major focus for juvenile rearing surveys undertaken in the New Projects studies and are not described quantitatively in either tables or figures. The following discussion compiles subjective information from New Projects studies and presents temperature ranges of preferred rearing habitats (where known), describes temperature-limiting habitats, and compares New Projects data with physiological limits for juvenile salmonids.

Brett (1956) experimentally determined the upper and lower lethal limits for juvenile salmonids and recognized that these limits are subject to change through acclimation. For juveniles acclimated at 20°C, upper lethal limits were 25.1°C for chinook, 25.0°C for coho, 23.7°C for chum, 24.8°C for sockeye and 23.9°C for pink salmon. Lower lethal limits ranged from 0.0 to 0.8 °C with acclimation temperatures from 5 - 10°C. Similar to that observed for temperature in spawning habitats, natural limits are far within those stated above. Other factors such

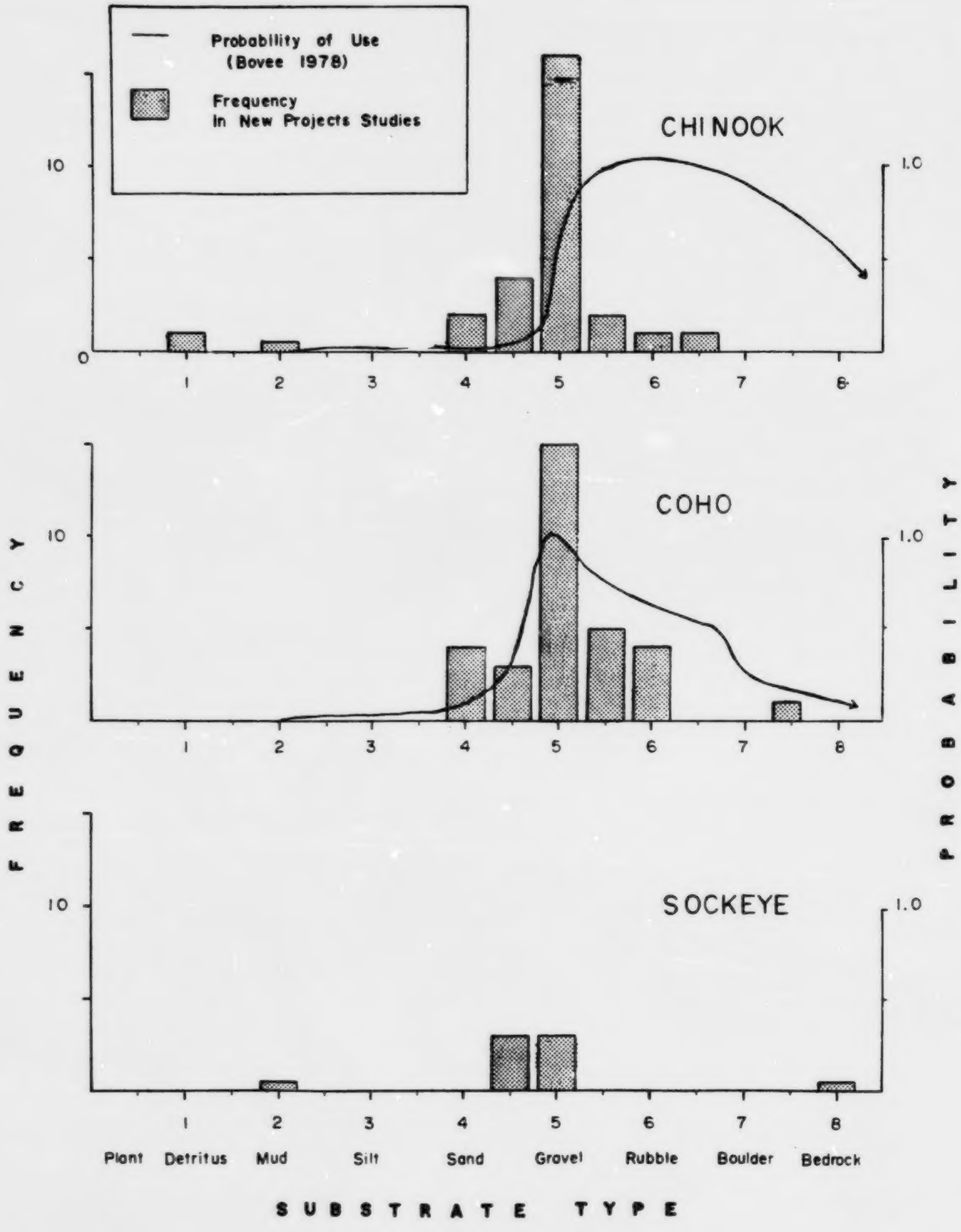

Figure 19. Types of substrate of preferred rearing habitats (see Tables 46 - 50 for details of data base).

as crowding, disease and behavioural changes have masked the effects of temperature stress. This was evidenced by several studies which captured and pen-reared chinook juveniles for tagging. Peak daily mortalities (1.32%) coincided with a mean daily temperature of 19.25°C in the Stuart River (13, 14). In the Quesnel River (16, 17) mortalities were also closely correlated with ambient water temperatures ≥15°C, although other factors such as pollen, algae growth and feed deficiencies also have had an effect.

Bovee (1978) indicated slightly warmer preferred temperatures for coho: approximately 13.9°C ($p>0.5$ from 10.0 - 20.0°C), compared to chinook at 12.8°C ($p>0.5$ from 10.0 - 18.3°C). Midsummer preferred habitats identified for juvenile coho in Kitimat River tributaries had temperature ranges of 11 - 14.5°C in July, and 9.0 - 10.0°C in August (11, 12).

Movements of rearing fish between and within streams are known to vary seasonally and have been related to water temperatures. Coho fry may have been attracted to the cooler water of McKinley Cr. instead of the mainstem Horsefly River (18.5°C compared to 20.2°C; 8). In two Stuart River tributaries with similar flow patterns, a rapid decline in the Kec Creek chinook population may have been due to lower June and July temperatures ([illegible] - 11°C) compared to nearby Welch Creek (14 - 17.5°C) where the rearing chinook population was still at a relatively high level in July (13, 14). Utilization of Hay Creek, a Willow River tributary, was probably limited by water temperature: daily maxima for July and August were 19 - 21°C whereas other tributaries never exceeded 18°C (21, 22). In South Thompson tributaries, rearing coho emigrated after water temperatures reached 19°C (38, 39). In May and June, chinook fry were rearing in tributaries with temperatures of 13 - 14°C, rather than in the mainstem Horsefly where temperatures were 8 - 9°C (8). In tributaries to the Middle Shuswap River in late September to early October (62, 63) when temperatures were 5.4 - 5.0°C, salmonids displayed overwintering behaviour (ie. fish were hidden in cover areas). Further discussion on factors that may have caused migrations of rearing salmonids is located in the earlier Cues to Migration section.

Several of the consultant studies (16, 17, 38, 39) noted that rearing juveniles were most abundant at times and in habitats with rapidly increasing temperatures.

Water Depth

The New Projects data are presented in Table 51 to clarify the source of the habitat depth information used to generate the frequency distribution (Figure 20). Most studies described the mean depth of a stream reach containing the highest concentration of juveniles. Others (e.g. diver observations in the Quesnel River; 8) used anecdotal information to describe habitats that seemed to be heavily utilized. In both cases, we have had to apply judgement in determining the preferred rearing area and subsequently used whatever depth data were associated with that habitat. These values consist of depth ranges, ranges of mean depths, and single values that imply a mean depth for a certain habitat. Depths were partitioned into 10 cm units, and lines were extended across a continuum to derive depth frequencies (Figure 14).

Chinook and coho were fairly wide in their depth preferences. Chinook were found in habitats from 60 - 90 cm in depth and coho were found slightly shallower, at 30 - 80 cm depths. Bovee also showed broad curves for both species, noting that chinook juveniles preferred depths of at least 40 cm (no upper limit was given on his probability-of-use curve) and coho fry preferred 40 - 100 cm. Bovee had no information for rearing sockeye; the New Projects data indicated the same tendency towards a broad range of depths in stream habitats.

Water Velocity

Velocity information was also described subjectively in many studies and was therefore transformed into a coded scale. Each category was judgementally assigned a value range so that measured velocities could be combined with velocity class information:

Class	Velocity Range (cm/sec)
Nil	0 - 10
Slow	10 - 30
Moderate	30 - 60
Fast	60 - 100
Very Fast	> 100

Table 51. Water depths associated with preferred rearing areas for chinook and coho juveniles in streams.

Stream/Year	Juvenile Age	Depth (cm)	Reference[a]
CHINOOK			
Stuart/1980	0+	60 - 100	13,14
Nechako/1979	0+	≤100	8
Swanson Cr/1979	0+	<50	8
Horsefly/1979	0+	100 (approx.)	8
Quesnel/1980	0+	200	16,17
Eagle/1981	0+	65 - 180 (mean)	38,39
Salmon/1981	0+	75 - 100	38,39
Adams/1981	0+	400	38,39
Blue/1981	0+ and 1+	50	34,35
Finn/1981	0+	30	34,35
Lion/1981	0+	30	34,35
Raft/1981	0+	70	34,35
COHO			
Gus/1983	unspecified	≤150	64,65
Horsefly/1979	unspecified	<100	9
Quesnel/1980	0+	200 - 300	16,17
Eagle/1981	0+	25 - 125 (mean)	38,39
Eagle/1981	1+ and 2+	50 - 65 (mean)	38,39
South Pass/1982	0+ and 1+	20	49
Salmon/1981	0+	75 - 80 (mean)	38,39
Adams/1981	0+	<20	38,39
Albreda/1982	0+	80 (mean)	54
Blue/1981	0+ and 1+	50	34,35
Finn/1981	0+ and 1+	30	34,35
Lion/1981	0+ and 1+	30	34,35
Wire Cache/1982	0+ and 1+	30	54
Raft/1981	0+	40	34,35
SOCKEYE			
Quesnel/1980	0+	1,000	16,17
Eagle/1981	0+	200	38,39
Salmon/1981	0+	40 - 100 (mean)	38,39
Raft/1981	0+	70	34,35
North Thompson/1981	0+	200 - 300 (mean)	34,35

[a] Reference document number (see Appendix A-1).

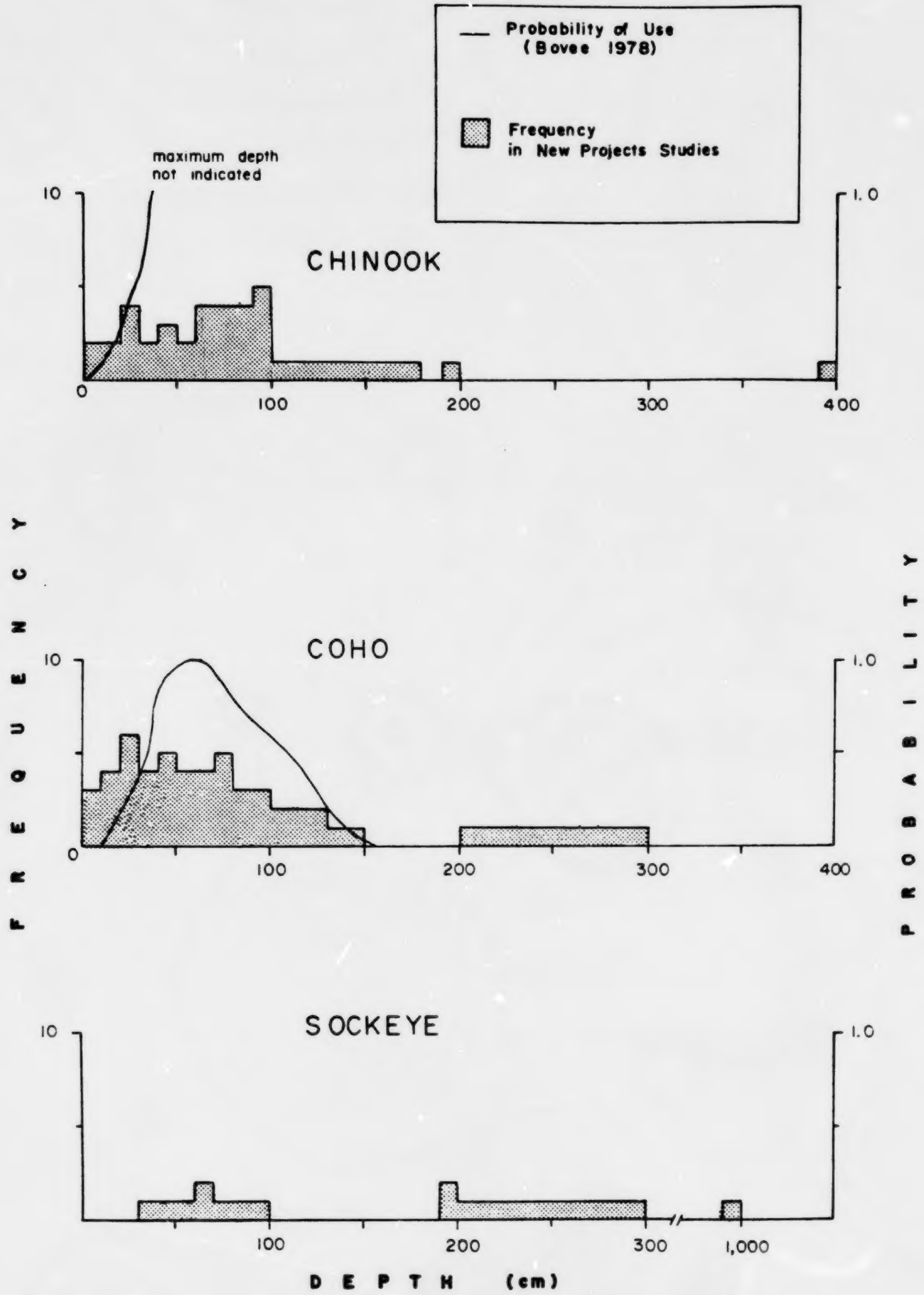

Figure 20. Depths of preferred rearing habitats (see Tables 46 to 50 and Table 51 for details of data base).

Although chinook and coho were found primarily in low velocity areas (10 - 30 cm/sec), there was some extension into moderate and high velocities up to 100 cm/sec (Figure 21), particularly for chinook. Bovee's data showed a similar mode at 10 - 40 cm/sec ($p>0.5$) and also indicated a right-tailed curve into higher velocities. Sockeye were found over velocities of 0 - 100 cm/sec, with no obvious preference within this range.

SUMMARY

During Phase I of SEP, $46.5 million was spent on design and construction of 26 separate hatchery projects. These activities were supported by $1.9 million of biological reconnaissance and $1.6 million of biological feasibility studies. Altogether, 38 separate field studies examined biological characteristics of salmon populations in the North and South regions, as well as extensive investigations in the Fraser River drainage, in order to provide biological design criteria for the engineering of these enhancement projects.

CHINOOK

Chinook salmon populations were characterized by variability in morphology, behaviour, life history and habitat utilization between and within populations and years of study. The timing of immigration into natal streams and spawning was similar between Upper Fraser and Thompson River stocks, in contrast to their staggered timing through the lower Fraser River. Both red and white fleshed stocks exist in the Fraser River, but they do not necessarily correspond to Upper Fraser and Harrison stocks, as has been assumed for fishery management purposes. Chinook preferred to spawn in faster water (approximately 1 m/sec), larger gravel (8 to 10 cm diameter) and were found in a wide variety of river conditions, up to at least 7 m in depth. They often were found spawning in the mainstem riffles of large rivers, or at lake outlets. Some prespawning mortality was noted in Upper Fraser stocks, apparently related to environmental stresses and disease factors. Annual escapement reports appear to have consistently under reported chinook stocks in all areas.

In sampling spawning populations for biological characteristics, capture techniques were unavoidably selective, particularly for sex related differences. Some populations appeared to have deviated from 1:1 sex ratios. Population age structures for chinook changed from year to

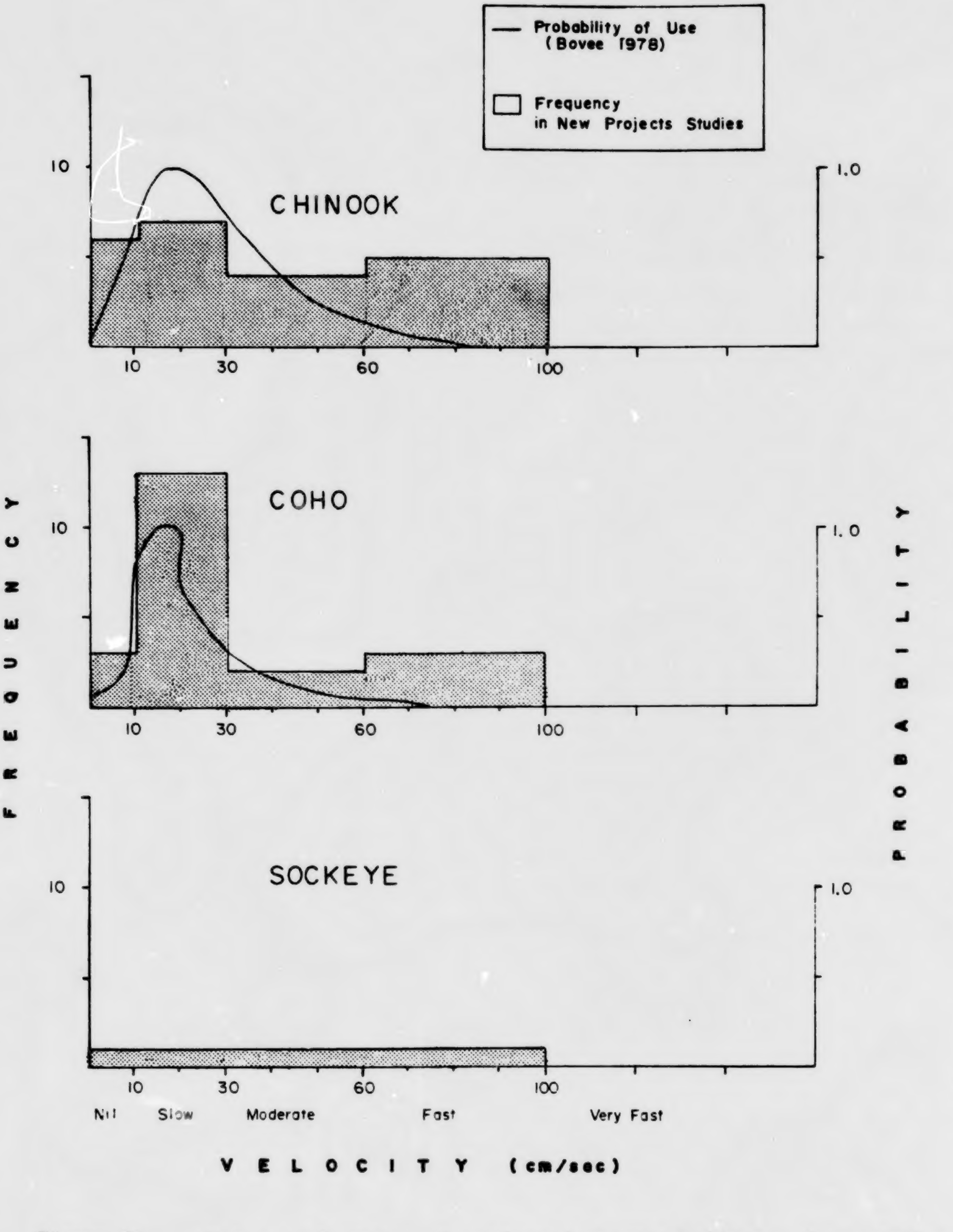

Figure 21. Water velocities of preferred rearing habitats (see Tables 46 - 50 for details of data base).

year in several rivers. Both total age and freshwater age was variable, particularly in Fraser River stocks; however, regional life history patterns were also evident. Females were larger than males at the same age, at least in the younger age groups (to 5_2) and male and female populations mature at different ages, especially those with sub-2 age designations. There was wide variation in chinook population fecundity, which was not explained by variations in length.

Ceratomyxa shasta is a myxosporidian that has been related to fish mortality in hatcheries and has also been reported throughout the Fraser River drainage. Subsequent testing on juvenile chinook has indicated that although all Fraser stocks tested were highly susceptible, a winter "timing window" exists for fish migrating through the lower Fraser.

Juvenile chinook were found rearing in the mainstem habitats of large rivers. Juvenile distribution changed from year to year within the same rivers. Fry emergence and initial downstream migration appeared to be cued by physical factors; however, rearing juvenile movements were correlated with both physical and biological factors. Competitive interactions were noted in certain areas and habitat changes were evident with fish growth. Rearing chinook densities were considerably lower than rearing coho densities, although this may have been an artifact of selection for study streams with potentially underutilized habitats. Chinook had wide variation in physical habitat preferences; although gravel substrate and low velocity areas were preferred, higher velocity areas and other substrate types were also important. Chinook were found rearing in water from 40 cm to 6 m deep and may rear in lake systems along the migration corridor. Chinook juveniles were also found in estuaries, although there was evidence that multiple life history patterns used the estuary and their degree of utilization varied. In general, Fraser River chinook emergent fry and 90-day fish emigrated from the study streams significantly later than in other areas, although 1+ timing was similar in all areas. South coast emergent fry were significantly larger in both length and weight than Fraser River fry.

COHO

Coho populations were the target species only in North and South Thompson studies. Due to concentrated efforts in these areas, coho data are biased towards these late-timing stocks. Coho were found spawning in small creeks, in scattered locations and were often holding in larger rivers and lakes before moving upstream. The presence of coho spawning in the Quesnel River represents an upriver extension in distribution of this species in the Fraser River watershed. Coho escapements were considerably under reported, especially in the North, where several important streams were listed as "not observed" in the DFO stream files. Coho spawners appeared to tolerate a larger proportion of fine bed materials and substrate size selectivity was not clear cut, perhaps due to habitat selection for other parameters. Coho spawned in water an average of 50 cm deep, and in relatively faster water than the other species (velocities of about 70 cm/sec). Water temperatures at spawning were consistently cold (4.5°C), reflecting the late timing of the stocks studied.

In many cases, it was difficult to get sufficient samples to adequately represent the population, even where coho were the target species. The 3_2 age class was highly dominant in all areas, but there was evidence of geographic variation in the prevalence of the 4_3 age group. North Coast coho were more likely to have significant 4_3 components than the other areas, although 4_3 fish were also found in the Thompson and Knight Inlet areas. The coho adults sampled indicated a relatively consistent size range (448 mm in the North Thompson area to 536 mm in the North Coast area) in the overall population. Fecundity ranged from 2,500 to 3,300 eggs/female and was positively correlated with length in all populations.

Juvenile coho were found along stream margins and in pools, lakes and swamps; 0+ and 1+ fish were often found rearing together. Coho juveniles exhibited a wide preference for substrate type as well as water depth (30 - 80 cm); velocity preference was generally "slow" (10 - 30 cm/sec). In those areas studied as to population densities, coho juveniles were at low densities, although higher than for chinook salmon. Again, this may be characteristic of the areas chosen for study. Coho fry were also found to make extensive use of the estuarine environment, exhibiting significant growth in some cases. Emergent fry in the Fraser River were significantly smaller in length and weight than those in the North and South regions. As with chinook, this difference was less evident with older juveniles. There were very few 2+ juveniles caught throughout the studies, although it is probable that this was an effect of the capture techniques used. Adult scales indicated that a significant portion of the adult population came from 2+ juveniles in some areas.

Coho timing and emigration patterns were confused by the unknown spawning locations of many stocks, and also by their protracted spawning period. These factors made it difficult to determine the significance of downstream and upstream movements, and also confound distinctions between rearing and migrating fry. There was slightly earlier emigration of coho fry from the Fraser River tributaries in comparison to streams in the

North and South, but this difference was not statistically significant. Emergent fry seem to be cued largely by physical factors, but unlike chinook, the downstream movement of rearing coho in streams was not clearly associated with population pressures. Coho movements between microhabitats often were associated with inceasing summer temperatures and decreasing flows. Note, however, that physical factors were more easily measured and correlated with fish movements than were biological factors.

CHUM

Several large populations of chum salmon were studied as the target species for enhancement. There was considerable disagreement regarding the abundance of some large populations: these studies became a practical test of mark/recovery programs and professional judgement became the ultimate deciding factor. Immigration and spawning timings were slightly earlier in the North than in the South, reflecting the presence of "summer" chum runs in northern systems. The effect of fisheries or obstructions in some areas may have also affected timing patterns. Chum salmon were found spawning in the lower reaches of rivers a few kilometers [illegible] tidewater, utilizing sidechannel, tributary and estuarine habitats [illegible] spawning. Chum habitat was characterized by moderately-sized gravel [illegible] cm diameter), shallow water (<1 m) and low velocities (40 - 60 [illegible]ec) with an average spawning temperature of 10°C.

Although there were generally sufficient samples available to determine the major population parameters, there were also some sex related differences that may have affected overall population statistics. In particular, carcass sampling was used extensively in field studies on this species; a technique which recovered significantly more females than males ($p<0.01$). The 4_1 age group predominated in all areas and although there were some 3_1 and 5_1 age components, there were almost no 2_1 or 6_1 fish. There was no evidence that age patterns shifted from year to year, as with chinook populations. Males were significantly larger than the females, both in the overall population as well as in the 4_1 age class. Fecundity data were most abundant for this species, and there was a close correlation between fecundity and length. Fecundities ranged from 2,100 - 3,100 eggs per female. No prominant disease organisms were found in chum spawners.

There was minimal freshwater rearing of chum salmon observed in these studies. Estuarine rearing was studied specifically and considerable utilization was evident, even though the residence time was short (days or weeks). Emergence timing appeared to be cued by physical factors, as with the other species, and was specific to a given river and stock. There were no significant differences in length, weight or condition factor of chum fry on a regional basis, despite extensive sampling on several river systems. Downstream timing was examined on a diurnal basis for chum fry and it was noted that early morning (01:30 - 09:00) migrations increased as the spring progressed, probably reflecting the later onset of dusk.

PINK

There were several large pink salmon populations studied. Immigration and spawning timings, as well as abundance estimates were in general agreement with DFO stream file information; however, the overall remoteness of these stocks usually prohibited independent estimates, unlike abundance estimates for chum salmon. The pink salmon stocks targetted for study were characterized by high-density holding and wave spawning patterns: up to 44% egg retention was noted, presumably as a result of high spawner densities. Pink salmon appear to select for smaller diameter substrates (average 17 mm diameter) and may be able to tolerate a larger temperature range (9.4°C average range per study) ing spawning than the other species, possibly as a result of their late summer timing. There were insufficient data to characterize water depth or velocity information, which was confounded by the fact that large segments of the populations were often spawning in clearly suboptimal areas. The sex ratio was not always 1:1, although the degree of gear or sampling selectivity was not generally determined. All the pink salmon sampled were assumed to be age 2_1 and only a few scale samples were taken to verify this assumption. There was no significant difference between lengths of males and females and lengths of the overall populations were relatively consistent (374 mm on the west coast Vancouver Island to 445 mm in the South Thompson). Fecundities ranged from 1,300 to 1,800 eggs per female. Even- and odd-year differences and their relationship to density-dependent population dynamics were not explored.

Pink salmon were found to have several disease agents, including bacterial kidney disease in the Tom Browne and Glendale stocks, and various protozoan disease agents in the Kwatna stock.

Freshwater rearing of pink salmon was not noted in any of the studies, and only a few pink juveniles were noted rearing in estuarine areas. Most individuals encountered were actively outmigrating. As with the other species, emergence timing appeared to be cued by physical factors. In particular, subgravel water temperatures were used to calculate ATUs to emergence and accurately predicted pink emergence timing under natural conditions in Glendale and Tom Browne Creeks. Overall, migration timing was specific to a given river. There were no significant differences in pink fry length, weight or condition factor, despite extensive sampling.

SOCKEYE

Although coastal British Columbia commercial fisheries are dominated by several large sockeye stocks, the populations studied by the New Projects Unit were mostly small populations. Most of the data obtained for sockeye were gathered incidentally while addessing the target species; consequently, timing and abundance estimates were in general agreement with the DFO stream file records. Sockeye spawners were found in a wide variety of habitats which were mostly, but not exclusively, associated with lake systems. Sockeye spawning habitat was characterized as 46% cobble and boulder, although a lack of overall substrate selectivity indicates that this species may be selecting for a different factor. The average spawning temperature was 11°C, and some spawners were found in very deep waters (>7 m). Sex ratios were adjusted to include jacks for all species; when considering sockeye data this had a substantial effect. For example, in the South Thompson and Nicola Rivers, 54.9% of the total population were age 3_2, whereas in the total North Coast only 2.1% of the population were age 3_2. All populations had large 4_2 age components, although 5_2 was predominant in the North and Adams River sockeye were 44% age 3_2. There was insufficient length data to compare regional or sex-related growth patterns and no direct attempt was made to obtain sockeye fecundity data.

Sockeye were found to carry several disease agents, including infectious hematopoetic necrosis (IHN) and furunculosis, in central coast streams. The presence of these disease agents will affect hatchery operations in the watersheds studied.

Juvenile sockeye were assumed to be rearing in several large lakes, although they were also found in the mainstem North Thompson River. There were very few sockeye fry found in estuary habitats, and those that were recovered were oriented towards freshwater sources. There was not enough information on sockeye to determine differences in juvenile timing patterns. Lengths, weights and condition factors of sockeye fry for various populations were not significantly different, partly due to a lack of data. Emergence timing appeared to be cued by physical factors, similar to the other species.

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REFERENCES[a]

Alderdice, D.F., F.E.A. Wood and D.W. Narver. 1984. Salmonid Enhancement Program — preliminary notes on new information in salmonid hatchery propagation. Can. Data Rep. Fish. Aquat. Sci. 496 102 p.

Anonymous, 1978. The Salmonid Enhancement Program. Can. Dept. Fish. Envir., Info. Br., Fish. Mar. Serv., Vancouver B.C. 86 p.

Aquatic Resources Limited. 1982. Central coast salmon tagging report for 1976, 1978 and 1979. Consultant Rep. prep. for Can. Fish. Oceans, Vancouver, B.C. 397 p.

Argue, A.W., R. Hilborn, R.M. Peterman, M.J. Staley, and C.J. Walters. 1983. Strait of Georgia chinook and coho fishery. Can. Bull. Fish. Aquat. Sci. 211 91 p.

Armstrong, R.W. and A.W. Argue. 1977. Trapping and coded-wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Can. Envir., Fish. Mar. Serv., Pac. Reg. Tech. Rep. PAC/T-77-14 58 p.

Arsenault, J.S. 1976. A field guide to streamflow measurement by gauging and metering. Can. Fish. Envir. Tech. Bull. Ser. PAC/T-76-2 40 p. plus appendices.

Bams, 1970. Evaluation of a revised hatchery method tested on pink and chum salmon fry. J. Fish. Res. Board Can. 27(8):1429-1452.

Banford, C. and D.D. Bailey. 1979. Blaney Creek chum project 1972-1977. Can. Fish. Envir., Fish. Mar. Serv. MS Rep. 1537 46 p.

Beacham, T.D. 1982. Fecundity of coho salmon (*Oncorhynchus kisutch*) and chum salmon (*Oncorhynchus keta*) in the northeast Pacific Ocean. Can. J. Zool. 60: 1463-1469.

Beacham, T.D. 1984. Age and morphology of chum salmon in southern British Columbia. Trans. Am. Fish. Soc. 113: 727-736.

Beacham, T.D. and P. Starr. 1982. Population biology of chum salmon, *Oncorhynchus keta*, from the Fraser River, British Columbia. Fish. Bull. 80:813-825.

---

[a] Refer to Appendix A-1 for details of those citations identified by number only.

Beacham, T.D., A.P. Gould and A.P. Stefanson. 1983. Size, age, meristics and morphometrics of chum salmon returning to southern British Columbia during 1981 - 1982. Can. Tech. Rep. Fish. Aquat. Sci. 1207.

Bjornn, T.C. 1971. Trout and salmon movements in two Idaho streams related to temperature, food, stream flow, cover and population density. Trans. Am. Fish. Soc. 100:423-438.

Bjornn, T.C. 1978. Survival, production and yield of trout and chinook salmon in the Lemhi River, Oregon. University of Idaho, College of Forestry, Bull. 127.

Bovee, K.D. 1978. Probability-of-use criteria for the family Salmonidae. U.S. Dept. Int., Fish, Wildl. Serv. Instream Flow Info. Paper No. 4 81 p.

Bovee, K.D. and T. Cochnauer. 1977. Development and evaluation of weighted criteria, probability-of-use curves for instream flow assessments. U.S. Dept. Int., Fish, Wildl. Serv. Instream Flow Info. Paper No. 3 39 p.

Brett, J.R. 1956. Some principles in the thermal requirements of fishes. Quart. Rev. Biol. 31:75-87.

Canada Department of Fisheries and Environment. 1977. Fish Health Protection Regulations, Manual of Compliance. Can. Fish. Envir., Fish. Mar. Serv., Misc. Spec. Publ. 31 81 p.

Chamberlin, T.W. 1980. Aquatic system inventory (biophysical stream surveys). A.D.P. Technical Paper 1, Aquat. Stud. Br., Min. Envir., Victoria, B.C. 33 p.

Chapman, D.W. 1962. Aggressive behaviour in juvenile coho salmon as a cause of emigration, J. Fish. Res. Board Can. 19:1047-1080.

Ching, H.L. and D.R. Munday. 1984. Susceptibility of six Fraser chinook salmon stocks to *Ceratomyxa shasta* and the effects of salinity on ceratomyxosis. Can. J. Zool. 62: 1081-1083.

Clutter, R.I. and L.E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bull. Int. Pac. Salmon Fish. Comm. 9.

Conlin, K. and B.D. Tutty. 1979. Juvenile salmonid field trapping manual. First edition. Can. Fish. Envir., Fish. Mar. Serv., MS Rep. 1530 136 p.

Cousens, N.B.F., G.A. Thomas, C.G. Swan and M.C. Healy. 1982. A review of salmon escapement estimation techniques. Can. Tech. Rep. Fish. Aquat. Sci. 1108 122 p.

De Leeuw, A.D. MS 1981. A British Columbia fish habitat and population stream inventory system. Fish. Wildl. Br., Min. Envir. Victoria, B.C.

Farley, A.L. 1979. Atlas of British Columbia. People, environment and resource use. Univ. Brit. Col. Press, Vancouver, B.C. 136 p.

Fedorenko, A.Y. and D.B. Bailey. 1980. Inches Creek chum pilot project, 1970-1978. Can. Fish. Envir., Fish. Mar. Serv., MS Rep. 1562 47 p.

Foerster R.E. 1968. The sockeye salmon, *Oncorhynchus nerka*. Fish. Res. Board Can. Bull. 162 422 p.

Fraser, F.J., P.J. Starr and A.Y. Fedorenko. 1982. A review of the chinook and coho salmon of the Fraser River. Can. Tech. Rep. Fish. Aquat. Sci. 1126 130 p.

Ginetz, R.M.J. 1977. A review of the Babine Lake Development Project 1961 - 1976. Can. Fish. Envir., Fish. Mar. Serv., Tech. Rep. Ser. PAC/T-77-6 192 p.

Gould, A.P. and A.P. Stefanson. 1985. Field examination of Nimpkish River sockeye timing and migration pathways in 1981 and 1982. Can. MS Rep. Fish Aquat. Sci. 1797 51 p.

Healy, M.C. and W.R. Heard. 1984. Inter- and intra-population variation in the fecundity of chinook salmon (*Oncorhynchus tshawytscha*) and its relevance to life history theory. Can. J. Fish. Aquat. Sci. 41: 476-483.

Helm, R.K., D. MacDonald, B. Sinclair, D. Chan, T. Herrington, A. Chalmers and B.G. Shepherd. MS 1980a. A review of the Nechako River watershed. Can. Fish. Oceans, Internal Rept., Vancouver, B.C. 128 p.

Helm, R.K., D. McDonald, B. Sinclair, A. Stuart, A. Chalmers and B.G. Shepherd. MS 1980b. A review of the Quesnel River Watershed. Can. Fish. Oceans, Internal Report, Vancouver, B.C. 72 p.

Hilland, R.T. 1979. Biological reconnaissance of chum salmon in the Bella Coola Valley to May, 1979. Can. Fish. Envir., Fish. Mar. Serv., MS Rep. 1543 47 p.

Hoar, W.S. 1976. Smolt transformation: evolution, behaviour and physiology. J. Fish Res. Board Can. 33:1234-1252.

Holmes, A.W. MS 1982. Salmon quality considerations for fisheries management. Can. Fish. Oceans, Internal Rept., Victoria, B.C. 109 p.

IPSFC, 1983. International Pacific Salmon Fisheries Commission Annual Report 1982. New Westminster, 46 p.

Koo, E.S.Y. [Ed.] 1962. Studies of Alaska red salmon. University of Washington Press, Publications in Fisheries Vol. 1.

Kwain, W. and S.J. Kerr. 1984. Return of 1-year-old pink salmon in Michipicoten River, eastern Lake Superior. N. Am. J. Fish. Mgmt. 4: 335-337.

Lister, D.B. and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish Res. Board Can. 27:1215-1224.

Lister, D.B. and R.A.L. Harvey. 1969. Loss of Peterson disk tags from spawning chum salmon *(Oncorhynchus keta)*. Can. Fish. Cult. 40:33-40.

Lister, D.B. and C.E. Walker. 1966. The effect of flow control on freshwater survival of chum, coho and chinook salmon in the Big Qualicum River. Can. Fish Cult. Vol. 32: 3-21.

MacDonald, D.D. and B.G. Shepherd. MS 1983. A review of the Kitimat River Watershed. Can. Fish. Oceans, Internal Rept., Vancouver, B.C. 163 p.

McDonald, J. 1960. The behaviour of Pacific salmon fry during their downstream migration to freshwater and saltwater nursery areas. J. Fish Res. Board Can. 17:655-676.

McDonald, J.E. MS 1979. Summary of biological knowledge of populations of B.C. and Yukon salmonids. Draft MS (updated), Salmonid Enhancement Program, Can. Fish. Oceans, Vancouver. 80 + 35 p.

MacKinlay, D.D. 1984. SEP New Projects Unit water quality and temperature data collected 1979-1984. Can. Data Rep. Fish. Aquat. Sci. 409 190 p.

McNeil, W.J. 1964. Redd superimposition and egg capacity of pink salmon spawning beds. J. Fish. Res. Board Canada, 21(6): 1385-1396.

Mason, J.C. 1975. Seaward movement of juvenile fishes, including lunar periodicity in the movement of coho salmon (*Oncorhynchus kisutch*) fry. J. Fish. Res. Board Can. 32:2542-2547.

Margolis, L. 1982. Parasitology of Pacific salmon - an overview. pp 135-226. In E. Meerovitch [Ed.] Aspects of parasitology - a Festschrift dedicated to the fiftieth anniversary of the Institute of Parasitology of McGill University, 1932 - 1982. McGill Univ., Montreal, P.Q.

Neilson, J.D. and G.H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Trans. Am. Fish. Soc. 110:554-556.

Orth, D.J. 1983. Aquatic habitat measurements. Pages 61-84. In L.A. Neilson and D.L. Johnson [Eds.] Fisheries techniques. Southern Printing Co., Blackburg, VA. 468 p.

Palmer, R.N. 1972. Fraser River chum salmon. Can. Envir., Fish. Serv., Pac. Reg. Tech. Rep. 1972-1 284 p.

Peacock, D., R. Goruk and P.E. Sprout. 1984. A review of the 1983 commercial salmon net fisheries in the central coast area of British Columbia (Areas 6, 7, 8, 9 and 10): catch, escapement and management strategies. Can. MS Rep. Fish. Aquat. Sci. 1766 54 p.

Peacock D., G. Curry, J. Greenlee, J. A. MacDonald and G. McEachen. 1986. A review of the 1984 commercial salmon net fisheries in the central coast area of British Columbia (Areas 6, 7, 8, 9 and 10): catch, escapement and management strategies. Can. MS Rept. Fish. Aquat. Sci. (in press)

Pearse, P.H. 1982. Turning the tide: A new policy for Canada's Pacific fisheries. Final report of the comittee on Pacific fisheries policy, Dept. Fish. Oceans, Vancouver, B.C. 292 p.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191 382 p.

Schouwenberg, W.J., C.C. Graham, J.E. Barnetson, S. Steele and M. Peters. MS 1980. Coastwide manageablilty/enhancement strategies. Unpubl. MS, Can. Fish. Oceans, Vancouver, B.C.

Shepherd, B.G. 1984. The biological design process used in the development of federal government facilities during Phase I of the Salmonid Enhancement Program. Can. Tech. Rep. Fish. Aquat. Sci. 1275 53 p.

Shepherd, B.G., G.F. Hartman and W.J. Wilson. 1986. Relationships between stream and intragravel temperatures in coastal drainages, and some implications for fisheries workers. Can. J. Fish. Aquat. Sci. 43:1818-1822.

Sigma Resource Consultants. 1979. Summary of water quality criteria for salmonid hatcheries. Consultant Rep. Prep. for Can. Fish. Oceans, Vancouver, B.C.

Stein, R.A., P.E. Reimers and J.D. Hall. 1972. Social interaction between juvenile coho (*Oncorhynchus kisutch*) and fall chinook salmon (*Oncorhynchus tshawytscha*) in Sixes River, Oregon. J. Fish. Res. Board. Can. 29:1737-1748.

Symons, P.E.K. and M. Waldichuk [Eds.]. 1984. Proceedings of the workshop on stream indexing for salmon escapement estimation, West Vancouver, B.C., 2-3 February, 1984. Can. Tech. Rep. Fish. Aquat. Sci. No. 1326 258 p.

Taylor, E.B. and P.A. Larkin. 1986. Current response and agonistic behaviour in newly emerged fry of chinook salmon, *Oncorhynchus tshawytscha*, from ocean- and stream-type populations. Can. J. Fish. Aquat. Sci. 43: 565-573.

Tredger, D. MS 1980. Standing crop etimates using the habitat unit methodology. Unpubl. MS Rept., Habitat Improvement Section, B.C. Fish. Wildl. Br., Victoria, B.C. 17 p.

Tripp, D. and P. McCart. 1983. Effects of different coho stocking strategies on coho and cutthroat trout production in isolated headwater streams. Can. Tech. Rep. Fish. Aquat. Sci. 1212 176 p.

Tutty, B.D. and F.Y.E. Yole. 1978. Overwintering chinook salmon in the Upper Fraser River system. Can. Fish. Envir., Fish. Mar. Serv. MS Rep. 1460 24 p.

West, C.J. 1978. A review of the Babine Lake Development Project 1961-1977. Can. Fish. Envir., Fish. Mar. Serv., Tech. Rep. 812 105 p.

Wood, J.W. 1979. Diseases of Pacific Salmon, their Prevention and Treatment. Wash. Dept. Fish., Hatchery Div., 3rd ed. Olympia, Washington.

APPENDIX A-1 - List of Contractors' Reports done for New Projects Unit during Phase I of SEP.

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1. Lister, D.B. 1979. Baseline biological, physical and chemical data study for proposed salmon enhancement projects on the Little Qualicum River. Prepared by D.B. Lister and Associates Ltd. 40 p. plus APPENDIX.

2. Glova, G.J., W.A. Grant, P.J. McCart and M.L. Jones. 1979. Chum salmon spawning enumeration, Mathers Creek, Princess Louise Island, British Columbia. 1978. Prepared by P. McCart Biological Consultants Ltd. 59 p.

3. Glova, G.J. and P. McCart, 1979. Salmon enumeration studies in five streams draining into Tlupana Inlet, B.C., 1979. Prepared by P. McCart Biological Consultants Ltd. 207 p.

4. Northern Natural Resource Services Ltd. 1979. Enumeration of Pacific salmon fry in Mathers Creek, Queen Charlotte Islands, in 1979. Prepared by Northern Natural Resource Services Ltd. 76 p.

5. Lister, D.B., G.D. Harris and D.G. Hickey. 1979. Juvenile salmon downstream migration study at Little Qualicum River, British Columbia. Prepared by D.B. Lister and Associates Ltd. 44 p. plus APPENDIX.

6. Glova, G.J. and P.J. McCart. 1979. Downstream migration enumeration of salmon fry in Tlupana Inlet on the west coast of Vancouver Island. Prepared by P. McCart Biological Consultants Ltd. 190 p. plus APPENDIX.

7. Grant, W.A. and P.J. McCart. 1980. Attempted feasibility study of a satellite hatchery operation at Mathers Creek, British Columbia. Prepared by P. McCart Biological Consultants Ltd. 25p.

8. Olmsted, W.R., P.W. Delaney, T.L. Slaney and G.A. Vigers. 1980. chinook salmon *(Oncorhynchus tshawytscha)* fry and smolt enumeration/marking project, Nechako and Quesnel/Horsefly Rivers, B.C. Prepared by E.V.S. Consultants Ltd. 196 p. plus APPENDIX.

9. Olmsted, W.R., M. Whelan, and G.A. Vigers. 1980. 1979 investigations of fall-spawning chinook salmon *(Oncorhynchus tshawytscha)*, Nechako and Quesnel/Horsefly Rivers, B.C. Prepared by E.V.S. Consultants Ltd. 85 p. plus APPENDIX.

10. McCart, P.J., O. Fleming, W.A. Grant and M. Walsh. 1980. Adult salmon enumeration in the Nitinat River, British Columbia. Prepared by P. McCart Biological Consultants Ltd. 69 p.

11. Birch, G.J., T.L. Slaney and M. Milko. 1981. 1980 investigations of downstream migrations and rearing distributions in juvenile salmonids of the Kitimat River, B.C. Prepared by F.F. Slaney and Company Limited. 104 p.

12. Birch, G.J., T.L. Slaney and M. Milko. 1981. 1980 investigations of downstream migrations and rearing distributions in juvenile salmonids of the Kitimat River, B.C. Prepared by F.F. Slaney and Company Limited. APPENDICES.

13. Lister D.B., I. Wallace and D.G. Hickey. 1981. Salmonid enhancement baseline investigations at Stuart River, British Columbia. PART 1 - 1980 juvenile chinook salmon study (VOLUME I). Prepared by D.B. Lister and Associates. 65 p.

14. Lister, D.B., I. Wallace and D.G. Hickey. 1981 Salmonid enhancement baseline investigations at Stuart River, British Columbia. PART 1 - 1980 juvenile chinook salmon study (VOLUME II - APPENDICES). Prepared by D.B. Lister and Associates Ltd. 39 p.

15. Hickey, D.G. and D.B. Lister. 1981. Salmonid enhancement baseline investigations at Stuart River, British Columbia, in 1980. PART II - Adult chinook salmon study. Prepared by D.B. Lister and Associates Ltd. 50 p. plus APPENDIX.

16. Whelan, M.A., W.R. Olmsted and R.W.J. Stewart. 1981. Studies of juvenile chinook salmon *(Oncorhynchus tshawytscha)* and other salmonids in the Quesnel River drainage during 1980. Prepared by E.V.S. Consultants Ltd. 105 p.

17. Whelen, M.A., W.R. Olmsted and R.W.J. Stewart. 1980. Studies of juvenile chinook salmon *(Oncorhynchus tshawytscha)* and other salmonids in the Quesnel River drainage during 1980. Prepared by E.V.S. Consultants Ltd. APPENDICES.

18. Olmsted, W.R., M.A. Whelen and R.W.J. Stewart. 1981. 1980 investigations of fall spawning chinook salmon *(Oncorhynchus tshawytscha)* Quesnel, Blackwater (West Road) and Cottonwood River drainages, B.C. Prepared by E.V.S. Consultants Ltd. 85 p. plus APPENDIX.

19. Murray, P.R. and S.R. Hamilton. 1981. Baseline biological data on adult chum salmon in the Kemano River system, 1979. Prepared by Envirocon Limited. 68 p. plus APPENDIX.

20. Murray, P.R. and S.T. Hamilton. 1981. Baseline biological data on adult chum salmon in the Kemano River system, 1979. Prepared by Envirocon Limited. APPENDICES.

21. Murray, P.R., S.R. Hamilton and G.O. Stewart. 1981. Studies on juvenile chinook salmon *(Oncorhynchus tshawytscha)* in the Bowron and Willow Rivers, B.C. during 1980. Prepared by Envirocon Limited. 85 p. plus APPENDIX.

22. Murray, P.R., S.R. Hamilton and G.O. Stewart. 1981. Data manuscript for studies on juvenile chinook salmon *(Oncorhynchus tshawytscha)* in the Bowron and Willow Rivers, B.C., during 1980. Prepared by Envirocon Limited. APPENDICES.

23. Murray, P.R., G.O. Stewart and S.R. Hamilton. 1981. Studies on adult chinook salmon *(Oncorhynchus tshawytscha)* in the Bowron and Willow Rivers, and Slim Creek, B.C., during 1980. Prepared by Envirocon Limited. 65 p. plus APPENDIX.

24. Murray, P.R., G.O. Stewart and S.R. Hamilton, 1981. Studies on adult chinook salmon *(Oncorhynchus tshawytscha)* in the Bowron and Willow Rivers, and Slim Creek, B.C. during 1980. Prepared by Envirocon Limited. APPENDICES.

25. Lister, D.B., D.G. Hickey and I. Wallace. 1981. Review of the effects of enhancement strategies on the homing, straying and survival of pacific salmonids. VOLUME I. Prepared by D.B. Lister and Associates Ltd. 51 p.

26. Lister, D.B., D.G. Hickey and I. Wallace. 1981. Review of the effects of enhancement strategies on the homing, straying and survival of pacific salmonids. VOLUME II. Prepared by D.B. Lister and Associates Ltd. APPENDICES.

27. Slaney, T., G. Birch and M. deBurgh. 1982. 1981 investigations of downstream migrations and estuarine rearing in juvenile salmonids of rivers in Kitimat and Kildala Arms, B.C. Prepared by Aquatic Resources Limited. 144p.

28. Slaney, T., G. Birch and M. deBurgh. 1982. 1981 investigations of downstream migrations and estuarine rearing in juvenile salmonids of rivers in Kitimat and Kildala Arms, B.C. Prepared by Aquatic Resources Limited. APPENDICES.

29. deBurgh, M. 1982. Identification guide to contents of juvenile chum stomachs from Kitimat Arm. Prepared by Aquatic Resources Limited. 18 p.

30. Fielden R. and T. Slaney. 1982. 1981 survey of salmonids spawning in selected streams of Knight Inlet, British Columbia. Prepared by Aquatic Resources Limited. 88 p. plus APPENDIX.

31. Slaney, T.L. and M.R. Milko. 1982. 1981 adult salmonid sampling program at the Kakweiken River Fishway, British Columbia. Prepared by Aquatic Resources Ltd. 57 p.

32. Slaney T.L. and M.R. Milko. 1982. 1981 adult salmon sampling program at the Kakweiken River Fishway, British Columbia. Prepared by Aquatic Rewources Limited. DATA APPENDICES.

33. Black, G. and G. Birch. 1982. Baseline limnological survey of Tom Browne Lake. Prepared by Aquatic Resources Limited. 56 p. plus APPENDIX.

34. Scott, K.J., M.A. Whelen, L.B. MacDonald, J.D. Morgan and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the North Thompson River drainage. PART I. Juvenile salmonid investigations. Prepared by E.V.S. Consultants Ltd. 169 p.

35. Scott, K.J., M.A. Whelen, L.B. MacDonald, J.D. Morgan and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the North Thompson River drainage. PART I - Juvenile salmonid investigations. VOLUME II - APPENDICES. Prepared by E.V.S. Consultants Ltd.

36. Scott, K.J., M.A. Whelen and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the North Thompson River drainage. PART II - Adult salmon investigations. Prepared by E.V.S. Consultants Ltd. 111 p.

37. Scott, K.J., M.A. Whelen, and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the North Thompson River drainage. PART II - Adult salmon investigations. VOLUME II - APPENDICES. Prepared by E.V.S. Consultants Ltd.

38. Whelen, M.A., L.B. MacDonald, J.D. Morgan and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the South Thompson River drainage. PART I - Juvenile salmon investigations. Prepared by E.V.S. Consultants Ltd. 169 p.

39. Whelen, M.A., L.B. MacDonald, J.D. Morgan and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the South Thompson River drainage. PART I - Juvenile salmon investigations. Prepared by E.V.S. Consultants Ltd. APPENDICES.

40. Whelen, M.A. and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the South Thompson River drainage. PART II. Prepared by E.V.S. Consultants Ltd. 133p.

41. Whelen, M.A. and W.R. Olmsted. 1982. 1981 biophysical studies of selected chinook *(Oncorhynchus tshawytscha)* and coho *(Oncorhynchus kisutch)* salmon - producing tributaries of the South Thompson River drainage. PART II. Adult salmon investigations VOLUME II. Prepared by E.V.S. Consultants Ltd. APPENDICES.

42. Rosberg, G.E. and D. Aitken. 1982. Adult chinook salmon studies in four tributaries to the Upper Fraser River, 1981. Prepared by Beak Consultants Ltd. 139 p.

43. Rosberg, G.E. and D. Aitken. 1982. Adult chinook salmon studies in four tributaries to the Upper Fraser River, 1981. Prepared by Beak Consultants Ltd. APPENDICES.

44. Rosberg, G.E., D. Aitken and E. Oguss. Juvenile chinook salmon studies in four tributaries to the Upper Fraser River. 1981. Prepared by Beak Consultants Ltd. 150 p.

45. Rosberg, G.E., D. Aitken and E. Oguss. Juvenile chinook salmon studies in four tributaries to the Upper Fraser River, 1981. Prepared by Beak Consultants Ltd. APPENDICES.

46. Rosberg, G.E., C.W. Rice and J. Millar. 1982. Adult salmonid reconnaissance studies in the Gardner Canal area of British Columiba, 1981. Prepared by Beak Consultants Limited. 133 p.

47. Rosberg, G.E., C.W. Rice and J.M. Millar. 1982 Adult salmonid reconnaissance studies in the Gardner Canal area of British Columbia, 1981. Prepared by Beak Consultants. APPENDICES.

48. Stewart, G.O., R.B. Lauzier and P.R. Murray. 1983. Juvenile studies in the North Thompson region of B.C. 1982. Prepared by Envirocon Ltd. 139 p.

49A. Sebastian, D.C. 1983. Outplanting opportunities for chinook, coho (and steelhead) in six selected tributaries of the South Thompson drainage, 1982. Fish Habitat Improv. Sect., Fish Wildl. Br. 110 p.

49B. Sebastian. D.C. 1983. Outplanting opportunities for chinook, coho (and steelhead) in six selected tributaries of the South Thompson drainage, 1982. Fish Habitat Improv. Sect., Fish Wildl. Br. APPENDICES.

50. Whelen, M.A., J.R. Arthur, W.R. Olmsted and J.D. Morgan. 1983. 1982 studies of spawning coho salmon *(Oncorhynchus kisutch)* in tributaries of the South and mainstem Thompson Rivers, B.C. Prepared by E.V.S. Consultants Ltd. 100 p.

51. Whelen, M.A., J.R. Arthur, W.R. Olmsted and J.D. Morgan 1983. 1982 studies of spawning coho salmon *(Oncorhynchus kisutch)* in tributaries of the South and mainstem Thompson Rivers, B.C. Prepared by E.V.S. Consultants Ltd. APPENDICES.

52. Fidler, L.E. 1983. Analysis methods applicable to the prediction of hatchery water conditioning system characteristics. A summary and report. 155 p.

53. Envirocon Ltd. and E.V.S. Consultants Ltd. 1983. Studies of the fish pathogen *Ceratomyxa shasta:* Its effects on resistance and salinity testing. 48 p.

54. Hutton, R., C. Manson, M. Lauder and P. Fee. 1983. Coho studies North Thompson system. Federal job creation program. 145 p.

55. Envirocon Ltd., and E.V.S. Consultants. 1983. Studies of the fish pathogen *Ceratomyxa shasta:* Its effect on chinook salmon of the Fraser system. II. Seasonal testing. 22p.

56. Smith, J.L. and G.F. Berezay. 1983. Biological reconnaissance of the Morice River system, 1978 - 1980. 77 p.

57. Smith, J.L. and G.F. Berezay. 1983. Biological reconnaissance of the Morice River system, 1978 - 1980. APPENDICES.

58. Sigma Environmental Consultants Ltd. 1983. Summary of water quality criteria for salmonid hatcheries. Revised Ed. 163 p.

59. Envirocon Ltd. 1984. Comparison of resistance to *Ceratomyxa shasta* among British Columbia and Oregon hatchery chinook salmon. 7 p.

60. Whelen, M.A. and J.A. Morgan. 1984. 1983 spawning salmonid studies in selected watercourses of Knight Inlet B.C. Prepared by E.V.S. Consultants Ltd. 171 p.

61. Whelen, M.A. and J.D. Morgan. 1984. 1983 spawning salmonid studies in selected watercourses of Knight Inlet, B.C. Volume II - APPENDICES. Prepared by E.V.S. Consultants Ltd.

62. Fee, J. and J. Jong. 1984. Evaluation of chinook and coho outplanting opportunities in the Middle Shuswap River above and below Shuswap Falls, Volume 1. Prepared by Alpha-Bioresource Environmental Consultants. 76 p.

63. Fee, J. and J. Jong. 1984. Evaluation of chinook and coho outplanting opportunities in the Middle Shuswap River above and below Shuswap Falls, Volume 2. Prepared by Alpha-Bioresource Environmental Consultants. APPENDICES.

64. Rice, C.W. 1984. Adult salmonid reconnaissance studies in the Burke Channel area of British Columbia, 1983. Prepared by I.E.C. Beak Consultants Ltd. 159 p.

65. Rice, C.W. 1984. Adult salmonid reconnaissance studies in the Burke Channel area of British Columbia, 1983. Prepared by I.E.C. Beak Consultants Ltd. APPENDICES.

66. Fidler, L.E. 1984. Design and analysis procedure applicable to hatchery aeration systems. Prepared by Penny Applied Sciences Ltd. 145 p.

67. Shepherd, B.G. 1984. Predicted impacts of altered water temperature regime on Glendale Creek pink *(Oncorhynchus gorbuscha)* fry. Can. MS Rep. Fish. Aquat. Sci. 1782: 55 p.

APPENDIX A-2: List of Contractors' Reports done for the New Projects Unit after Phase I, between April, 1984 and April, 1986.

Fedorenko, A.Y. and B.G. Shepherd. 1984. Indian River feasibility studies. Groundwater exploration 1972-1982 and chinook pilot hatchery operation 1979-1980. Can. MS Rep. Fish. Aquat. Sci. 1767: 63 p.

Fedorenko, A.Y. and E.A. Perry. 1984. Production of coho reared in seapens in Indian Arm, 1978 and 1979 brood years. Can. MS Rep. Fish. Aquat. Sci. 1768: 55 p.

Fedorenko, A.Y. and B.G. Shepherd. 1984. Review of salmonid resource studies in Indian River and Indian Arm, and enhancement proposals for the area. Can. MS Rep. Fish. Aquat. Sci. 1769: 30 p.

Elson, M.S. 1985. A review of the Pitt River watershed. Prepared by Northern Natural Resource Services Ltd., 129 p. plus APPENDIX.

Bowman, S.L. and G.O. Stewart. 1985. Middle Shuswap River juvenile salmonid reconnaissance program, 1984. Prepared by Envirocon Ltd. 54 p. plus APPENDIX.

Fielden, R.J., T.L. Slaney and G.J. Birch. 1985. Knight Inlet juvenile reconnaissance. Prepared by Aquatic Resources Ltd. 214 p.

Fielden, R.J., T.L. Slaney and G.J. Birch. 1985. Knight Inlet juvenile reconnaissance. APPENDICES. Prepared by Aquatic Resources Ltd. 527 p.

Morgan, J.D. 1985. Biophysical reconnaissance of the Kitsumkalum River system, 1975-1980. Prepared by E.V.S. Consultants Ltd. 141 p.

Birch, G.J. 1985. Adult salmonid reconnaissance of selected Gardner Canal streams in 1984. Prepared by Aquatic Resources Ltd. 205 p.

Birch, G.J. 1985. Adult salmonid reconnaissance of selected Gardner Canal streams in 1984. APPENDICES. Prepared by Aquatic Resources Ltd. 182 p.

Del Mistro, L.A. and G.J. Birch. 1985. Downstream migrations and estuarine rearing of juvenile salmonids in the Kemano River drainage during 1984. Prepared by Aquatic Resources Ltd. 211 p.

Del Mistro, L.A. and G.J. Birch. 1985. Downstream migrations and estuarine rearing of juvenile salmonids in the Kemano River drainage during 1984. APPENDICES. Prepared by Aquatic Resources Ltd. 390 p.

Williams, R.A., G.O. Stewart and P.R. Murray. 1985. Juvenile salmonid studies in the Sustut and Bear Rivers, B.C., 1984. Prepared by Envirocon, Ltd. 156 p.

Williams, R.A., G.O. Stewart and P.R. Murray. 1985. Juvenile salmonid studies in the Sustut and Bear Rivers, B.C., 1984. APPENDICES. Prepared by Envirocon Ltd. 80 p.

McGivney, K.K., G.J. Holowatiuk and P.R. Murray. 1985. South Bentinck Arm Adult Salmonid Reconnaissance Program. Prepared by Envirocon Ltd. 140 p.

McGivney, K.K., G.J. Holowatiuk and P.R. Murray. 1985. South Bentinck Arm Adult Salmonid Reconnaissance Program. APPENDICES. Prepared by Envirocon Ltd. 123 p.

McGivney, K.K., S.L. Bowman and P.R. Murray. 1985. Smith Inlet adult salmonid reconnaissance program 1985. Prepared by Envirocon Ltd. 110 p.

McGivney, K.K., S.L. Bowman and P.R. Murray. 1985. Smith Inlet adult salmonid reconnaissance program 1985. APPENDICES. Prepared by Envirocon Ltd. 117 p.

Scott, K.J. and W.R. Olmsted. 1985. Migration of juvenile chinook *(Oncorhynchus tshawytscha)* and coho *(O. kisutch)* salmon and steelhead trout *(Salmo gairdneri)* in the Nicola River drainage, 1984. Volume I - Technical Report. Prepared by W.R. Olmsted and Associates, Inc. 115 p.

Scott, K.J. and W.R. Olmsted. 1985. Migration of juvenile chinook *(Oncorhynchus tshawytscha)* and coho *(O. kisutch)* salmon and steelhead trout *(Salmo gairdneri)* in the Nicola River drainage, 1984. APPENDICES. Prepared by W.R. Olmsted and Associates, Inc. 115 p.

RECONNAISSANCE PROGRAM OUTLINE

INTRODUCTION

The goal of the following program is to provide biological and physical information to be used by the Department of Fisheries and Oceans in planning and implementing salmonid enhancement facilities to service salmonid stocks from the

____

____.

Emphasis is to be placed on ____

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GENERAL CONSIDERATIONS

( ) The bidder should recognize the potential hazards associated with bioreconnaissance conducted, often in remote locations, for the New Projects Unit. The bidder should detail a safety plan for the project, and will have to provide proof of coverage for WBC and liability insurance upon award of contract. The plan should outline means of communication between crews, from crews to base camp, and from crews and camps to nearest civilization; provision of safety equipment felt appropriate, such as life jackets, radios, and firearms; first aid training of field personnel and on-site medical supplies; and any other relevant information. A contingency plan for a serious medical emergency should also be detailed.

( ) The field camps must have copies of both the RFP and the successful proposal for the field crew to review, and all crew leaders are expected to be fully familiar with both.

( ) Project progress also will be assessed by an independent Progress Reporter. The Contractor is expected to cooperate fully with the Progress Reporter and provide all reasonable assistance in sharing travel and accommodation arrangements. The bidder is to outline how a copy of each of the Progress Reporter's trip reports is to be expediently provided to the field crews, and how any program adjustments confirmed as necessary by the Scientific Authority will be communicated to the field crews.

( ) All ropes or wires spanning rivers must be flagged or otherwise obviously marked during the period of study, and removed at the conclusion of the field program.

PART . JUVENILE SALMONID RECONNAISSANCE PROGRAM

OBJECTIVES

( ) To determine the migration timings, numbers, and the size and age distributions of ________________ juveniles emerging, migrating from and/or rearing in the ____
____
____
____

Methods and analyses must be compatible with and complement (fill in data voids) the 198_ study on the ________________________________.

( ) To capture, and tag with coded-wire nose tags and do adipose fin-clips on a minimum of 20,000 coho/75,000 chinook juveniles on the ____________________ River, in order to determine adult distribution and migration routes and their contribution to the various fisheries.

( ) To inventory habitats in relation to utilization by ________________ fry.

( ) To record daily water temperatures and levels, and to determine water quality in order to assess potential limitation to salmonids.

( ) To submit a final comprehensive report on the methods and results of the above programs, which discusses the implications that the results may have for proposed enhancement techniques. The bidder is referred to consultant reports published in-house during 19__, as to format approaches acceptable to the Scientific Authority (see References Section).____________________

( ) ____________________

SCHEDULE

Mobilization to begin by ______________ 198_. Field work from ___________ to _____________, 198_. Draft report to be received by Scientific Authority by ____________, 198_; final report submitted by _____________, 198_.____________

METHODS

_. Water Temperature, Level, and Quality

( ) Record water temperatures and levels daily on the _________________, three times per week on the ____________, at predetermined sites and at a standardized time. Report temperatures as Max/Mean/Min. per site over the study period. Thermometers used are to be checked against a calibration thermometer. Staff gauges are to be installed above tidal influence, and bench marked to permanent features and photographed in case of wash-out. All staff gauge installations should be reported in sufficient detail to allow reinstallation in future studies. Where possible, gauge sites used in 19___ should be used again, to allow inter-year comparison.

( ) Collect water samples at selected sites on each river for analysis by the DFO's Cypress Creek Lab, 4195 Marine Drive, West Vancouver, B.C. V7V 1N8. (Details/Sites as per Section _____)

( ) Full series (Enclosure 1) to be taken at approximately monthly intervals from the start of field work. Sampling to be coordinated such that shipment to Cypress Creek will be complete within 48 hrs, and will arrive at the lab before noon on Friday (of a normal work week). Samples to be packed in ice in coolers for shipment.

( ) One-liter samples of river or creek water to be taken whenever discharge is unusually high or dirty. These samples can be frozen (leave air space) for analysis by DFO lab after completion of field work.

( ) Sampling bottles, sampling request forms (see Enclosure 2), and reagents will be provided by DFO.

( ) On-site determination of pH (±0.5 units) and temperature (±0.5°C) to be done when lab samples are taken. Means of calibration are to be outlined.

( ) Provide stream discharge data for the period of study from Water Survey of Canada records where available, or by the velocity-area method at representative sites and stages, using a current meter (see Arsenault 1976). The stage-discharge curve is to be developed using at least four points spread over the range of flows experienced during the study.

( ) Obtain daily precipitation data for the period of study from the nearest weather station, if representative, and/or by installing 'Tru-Chek' rain gauges (or their equivalent in accuracy).

( ) Measure temperature and salinity weekly on peak flood and ebb tides at selected sites (so as to delineate the extent of estuarine influence up to 30°/∘∘) at ______________________________, at the surface, 2m and 5m depths. Also to be done at potential seapen sites, where identified. Outline means of calibration for temperature and salinity values.

_. Migrating Fry and Smolts

( ) Employ the following traps where appropriate: converging throat weir traps, floating inclined-plane traps, fykenet traps with restrictive throats and liveboxes, wire minnow traps, seines, electroshocking, or other methods acceptable to the Scientific Authority.

( ) The preferred trap type is ______________________ (Conlin and Tutty, 1979). Suggested locations are as follow: __________________________

____

____

A fully operable spare trap should be available on-site throughout the trapping period. Flotation for 2X3 1PTs should be 18 ft^3 at a minimum, and extra flotation should be available on-site (logs not acceptable). Alternate trap types may be utilized, subject to approval of Scientific Authority. The contractor should recognize that the capture of smolts and the survival of captured fish are to be maximized, and choice of location and set-up should be considered in that light.

( ) Place emergence migration index traps below major spawning grounds, but above significant tidal influence. Smolt migration index traps should be placed downstream of significant rearing areas.

( ) Trap juveniles at least from dusk to dawn (usually the most active period of fry migration), three times per week on alternate nights; trap nightly during periods of significant migration (when nightly migrations exceed 1% of the expected migration). Some daytime trapping should be carried out on each river during peak migration periods.

( ) Trap juveniles from dusk to dawn (usually the most active period of fry migration), three times per week on each river on alternate nights. Some daytime trapping should be carried out on each river during peak migration periods.

( ) During periods of significant migration (see   ) carry out 24 hour trapping once a week (more often if large changes in water level occur). On these occasions, the number of fry captured should be determined every 2 hr.

( ) Maintain optimum trapping efficiency by regular inspection and cleaning of trapping gear during the night.

( ) Estimate the entire catch per trap by species, fry and smolt stage, using weight or volume subsamples with a minimum of three replicates, each with 200 - 300 fry, if possible. Count incidental species and release immediately. Retain type specimens preserved in 10% formalin for verification of identification by Technical Monitor/Scientific Authority.

( ) Keep separate, direct counts of all capture mortalities by trapping method, species, and life stage.

( ) Conduct biological sampling as follows:

  ( ) sample a minimum of 10 juveniles from each species each trapping day throughout the migration period. (NOTE: "juveniles" includes fry and smolt stages which should be treated separately.) Increase sample size if there are significant size variations;

  ( ) anaesthetize fish with MS 222 or 2-phenoxyethanol anaesthetic, pat dry, weigh, measure nose-fork length, take scale smears from smolts (DFO personnel will interpret scales), and examine for degree of yolk absorption and natural anomalies[a]; release revived fish;

  ( ) maintain measurement accuracy of ± 0.5 mm for length and ± 0.1 g for weight;

  ( ) calculate developmental index or condition factor for individual fish of each sample group (not pooled).

$$K_D = \frac{10\sqrt[3]{W(\mathrm{mg})}}{L(\mathrm{mm})} \text{ for alevins and emergent fry;}$$

$$\text{Fulton's } K = \frac{100W(\mathrm{g})}{L^3(\mathrm{cm})} \text{ for later fry and juveniles.}$$

( ) Where diseased[a] fry are noted, expedite shipment of an appropriate number of live juveniles of each salmonid species found to Diagnostic

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[a] Including naturally-missing adipose fins, pop eye, fog eye, scale loss, fin or tail rot, fungus, scoliosus, blood fluke, rubbed nose and split dorsal fin.

Services, Pacific Biological Station, Nanaimo, for diagnosis. Sampling and shipping procedures are to be as per DFO Fish Health Regulations Manual of Compliance, page 13. G. Hoskins at the Station will provide system-specific sampling requirements to the successful bidder.

( ) Potential predators of fry also caught in the traps should be sub-sampled as to stomach contents.

( ) Develop population estimates for ________________ preferably by using trap efficiency based method on mark-recapture (dye-test outlined below), or using proportionate sampling methods (fractions of stream discharge, of wetted width, and of cross-sectional area sampled).

( ) Conduct dye tests weekly to determine the trapping efficiency of gear (more often if large changes in water level occur that may alter trap efficiency). Initially, one thousand _________________ (if possible) are to be held in Bismarck Brown Y solution (0.5 - 0.7 g dye in 40 l water) for three hours and released at dusk approximately 1 km above traps. Conduct recaptures the following two mornings. Size of succeeding test lots may be altered dependent on numbers of recaptures.

( ) In developing population estimates, consider all bias in the trapping method and limitations of the data, and develop correction factors for the probable sources of error (e.g. proportion of spawners below the traps).

( ) Sampling methods, locations and analyses are to be compatible with those used in the 198_ study done by____________.

_. Rearing Juveniles

( ) Where not done in 198_, characterize by means of standard bio-physical survey methods (eg. B.C. Aquatic Studies Branch or the BCFW "habitat unit" sampling techniques), each homogeneous reach and sidechannel of each river (length, width, depth, substrate, slope, obstructions, cover, etc.) to determine stream area apparently suitable and available to rearing ____________________ juveniles.

____

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____

( ) Determine the duration and distribution of rearing _______________ juveniles by establishing fixed trapping sites to represent specific stream sections (see Section _____, above) and carry out systematic minnow trapping, electroshocking and/or seining over at least three key sampling periods. The sampling program shall include checks of watershed areas upstream of known or suspected partial obstructions to anadromous salmonid migration. Contingency plans in the event of equipment failure should be outlined.

( ) Develop population estimates of rearing juveniles using accepted mark-recapture methods. The estimate made for one stream section may be extrapolated to an adjacent river reach having similar habitat and flow characteristics, using a calibration factor (e.g. 1 fish per minnow trap in the dye-tested section represents 'X' fish in the extended river reach).

( ) Estimate actual and potential habitat utilization by rearing ________ juveniles, using accepted methods (see Section ____).

( ) Establish growth patterns of juvenile fish for the duration of the sampling program for each river section, for each type of trapping gear used, and by species and stage (see Section ____).

( ) Identify those areas seasonally suitable for in-stream rearing or holding of fry for imprinting. Suitable areas may be found in lakes, ponds, or instream pools and backeddies with >1m depth and <0.3 m/sec velocities, that are protected from freshets and floating ice or debris.

( ) Methods, sampling locations and morphometric classifications in this section are to be compatible with those used during the _____________ study.

( ) Keep separate records of all mortalities.

_. Juvenile Tagging

( ) Trap juvenile ____________________ later in the season at larger fry size (approximately 500 fish/kg or 50 mm length) and tag at the time of capture. Fry are not to be collected during the emergence migration, but rather during the later stages of the rearing fry study.

( ) Construct a weir (fence) trap near the mouth of ______________ Creek below major spawning and rearing areas, or use other appropriate traps (see Section ___).

( ) Operate the traps continuously to obtain the minimum specified quota of ____________ juveniles.

( ) Maintain optimum trapping efficiency by regular inspections and cleaning of fence and live box screens. Potential predators should be removed and subsampled to determine their impact on trap catches of target species. Document trapping mortalities.

( ) Trap juveniles early in the season during their active migration and rear in net pens to tagging size.

( ) Trap juveniles later in the season at larger fry size and hold in net pens until sufficient numbers for tagging are accumulated. Do not hold for long periods of time if this interferes with migration timing.

( ) Carry out rearing procedures according to standard DFO fish culture practices (use of OMP food and feeding schedules; regular cleaning, inspecting and sampling (see section ____) of lots, tabular data reporting and daily log keeping).

( ) Provide finclipping and tagging services where required. DFO will provide wire tags and tagging machinery.

( ) Perform quality control tests (tag loss, tag placement, and fin clip) and assess tagging-related mortality.

_. Estuarine Studies

( ) Observation of __________ utilization of the __________ estuarine, foreshore and nearshore environs should be conducted weekly, and sampling carried out opportunistically.

( ) Employ the following traps where appropriate: dip nets, set nets, seines, or other methods acceptable to the Scientific Authority.

( ) Trap juveniles three times per week in the __________________________ estuary and weekly in the ____ estuary during migration and estuarine rearing.

( ) Contractor is to record all trapping mortalities, and should make all possible adjustments to minimize mortality, including release of catches at night to avoid predation.

( ) Maintain optimum trapping efficiency by regular inspection and cleaning of trapping gear.

( ) Estimate the entire catch per trap by species, fry and smolt stage, using weight or volume subsamples with a minimum of three replicates, each with 200 - 300 fry, if possible. Count and release immediately incidental species. Retain type specimens preserved in 10% formalin for verification of identification by the Scientific Authority.

( ) Conduct biological sampling as follows:

( ) wherever possible, sample a minimum of 10 juveniles from each species (except chinook) on each trapping day throughout the migration period.

( ) anaesthetize fish with MS 222 anaesthetic, pat them dry, weigh, measure nose-fork length, take scale smears from larger juveniles, and release revived fish.

( ) maintain measurement accuracy of ± 0.5 mm for length and ± 0.01 g for weight (use electric balance if available).

( ) calculate developmental index condition factor for each sample group.

$$K_D = \frac{10\sqrt[3]{W(mg)}}{L(mm)} \text{ for emergent fry;}$$

$$\text{Fulton's } K = \frac{100W(g)}{L^3(cm)} \text{ for all others.}$$

( ) examine stomach contents of several lots of 10 juveniles collected periodically throughout migration and rearing and identify and enumerate major food species (preferably to genus level). Preserve type specimens for future reference.

( ) Establish growth patterns of juvenile ___________ for the duration of the sampling program for each estuary and for each type of trapping gear used.

( ) A "zooplankton watch" is to be conducted as follows:

( ) Sites are to include the nearshore areas of _____________ estuary where _____________ fry are observed to be feeding; and a fixed reference station at the center of ________________________________

____

____

( ) Zooplankton sampling is to focus on the ______________ species normally predominant in ____________ diets. The contractor is to delineate methods required.

( ) Sampling is to be done at least every five days at each site.

( ) A Miller sampler or similar (200 µ mesh net and 0.01 m^2 mouth) is to be towed at the water surface for approximately 300 - 400 m. The tows are to be done at dusk (about 2000 hr) at speeds of 1 - 2 knots/hr. The distance towed is to be determined with a Gurley Pygmy Current Meter held over the side of the boat. The samples are to be preserved in 10% formalin for analysis.

( ) In analysing the zooplankton samples, the larger organisms such as jelly-fish, tunicates etc., are to be excluded. The remaining organisms are to be identified and enumerated. Samples containing large numbers of organisms can be subsampled using a plankton splitter before identification and enumeration. Results from the examination of subsamples are then to be multiplied by the splitting factor to estimate the numbers of organisms in the total sample.

( ) After enumeration, each sample of plankton is to be filtered through a fine screen (0.2 mm sq. mesh) and the residue weighed after drying for 5 minutes at room temperature on a circle of filter paper. Total weight of each sample is to be used to provide an estimate of zooplankton standing crop (mg/m^3), by dividing total damp weight by the volume of water sampled during tows.

( ) Stomach content samples are to be used together with the plankton samples to estimate the seasonal abundance of the major food organisms.

( ) Conduct a habitat survey of _____________ rearing areas in each estuary and prepare map of preferred habitats.

( ) Estimate the potential rearing capacity of the estuary for _____.

( ) ____
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____
____

( ) The distribution and major movements of pink and chum fry from each estuary are to be described.

( ) For each estuary, complete observations of sheltered areas, currents, predators, human activities, ice formation, etc., which may affect use of area for seapens.

( ) Provide wind data from existing weather stations or by measurement during the period of study ('roses' are the preferred method of presentation).

_. Reporting

( ) Submit monthly brief progress reports containing summaries of current data and any significant findings.

( ) Submit two copies of a draft report by ____________________, 19__ presented in a clear and comprehensive manner, which outlines the methods employed and results obtained, and discusses the latter in relation both to prior relevant studies and to potential enhancement measures.

( ) The final report shall also include a watershed description (physical features, climate, land use, access, maps, etc.) and a background on the salmonid populations in question based on available records.

( ) Submit the camera-ready originals and one bound copy of the final approved report by ____________ 198_.

( ) Raw data and summaries should be included in a separate bound appendix (two copies). Due to publication costs, DFO will not publish appendices.

( ) ____
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Part . ADULT SALMONID RECONNAISSANCE PROGRAM

OBJECTIVES

( ) To determine the spawning escapement, timing and distribution of adult __________________ and incidental species in the ___________________ _____ River systems.

( ) To obtain length, age and sex composition, fecundity, and egg retention data for the spawning populations of __________________.

( ) To record water temperatures, levels, precipitation, stream discharge and water quality in the systems under study.

) To describe those physical aspects of the systems relevant to spawning success, including stream width, depth, gradient, substrate composition and the presence of obstacles to migrants.

( ) ____
____
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____

( ) To submit a final comprehensive report on the methods and results of the above programs, and which discusses the implications that the results may have for the proposed enhancement techniques. The report must be compatible with that done by _______________ in 198_.

( ) ____
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____

SCHEDULE

Mobilization to occur by ________________, 19__. Field work from ______ ____________ to __________________ , 19__. Draft report to be received by Scientific Authority by _________________, 19__. Final report to be submitted by _____________, 19__.

METHODS

_. Water Temperature, Level, and Quality

( ) Record water temperatures (max/mean/min) and levels daily at pre-determined sites and at a standardized time. Thermometers used are to be checked against a calibration thermometer. Staff gauges are to be installed above tidal influence, and benchmarked to permanent features and photographed in case of wash-out. All staff gauge installations are to be reported in sufficient detail to allow reinstallation in future studies.

( ) At the conclusion of the adult field program, the contractor is to continue monitoring of daily water temperatures at_____________ using Ryan thermographs or locally-hired personnel (or another method acceptable to the Scientific Authority). Temperatures are to be monitored until____________, 19__, and are to be submitted separately from the main report by ______________, 19__.

( ) Take spot temperatures in active spawning areas using calibrated pocket thermometers.

( ) Collect water samples at selected sites for analysis by the DFO's Cypress Creek Lab, 4195 Marine Drive, West Vancouver, V7V 1N8. (Details/Sites as per Section _____).

    ( ) Full series (Enclosure 1) to be taken at approximately monthly intervals from the start of field work. Sampling to be coordinated such that shipment to Cypress Creek will be complete within 48 hours, and will arrive at the lab before noon on Friday (of a normal work week). Samples to be packed in ice in coolers for shipment.

( ) One-liter samples of river or creek water to be taken whenever discharge is unusually high or dirty. These samples can be frozen (leave air space) for analysis by lab after completion of field work.

( ) Sampling bottles, sampling request forms (see Enclosure 2), and reagents will be provided by DFO.

( ) On-site determination of pH (±0.5 units), and temperature (±0.5°C) when lab samples are taken. Means of calibration are to be outlined.

( ) Provide stream discharge data for the period of study from Water Survey of Canada records where available, or by the velocity-area method at representative sites and stages, using a current meter (see Arsenault 1976). The stage-discharge curve is to be developed using at least four points spread over the range of flows experienced during the study.

( ) Obtain daily precipitation data for the period of study from the local weather station, if representative, or by installing 'Tru-Chek' rain gauges (or their equivalent in accuracy).

( ) Measure temperature and salinity on peak flood and ebb tides at selected sites approximately weekly (so as to delineate the extent of estuarine influence up to 30%) adjacent to the mouth of ______________ _______, at surface, 2m, and 5m. Also to be done at potential seapen sites, where identified. Outline means of calibration for temperature and salinity values.

( ) ____
____
____
____

_. Biophysical Parameters

Where not done in 198_:

( ) Characterize by means of standard bio-physical survey methods (e.g.

B.C. Aquatic Studies Branch), each homogeneous reach and side channel of each river (depth, width, slope, substrate, riffle, pool, cover, etc.).

( ) Describe for each homogeneous reach in the main stream and major tributaries the following features: meander length; slope; floodplain and wetted channel width; presence and size of side channels; proportion of area classed as pool, riffle and rapid; and substrate type and composition.

( ) Describe all possible obstacles to upstream passage of salmon migrants.

( ) Using the above data, determine the stream area apparently suitable and available for holding and spawning by salmon.

( ) Determine the morphometry of each estuary by accepted methods.

( ) Note factors which may affect utilization of the estuary for seapen rearing, such as human activities, predators, sheltered areas, currents, etc.

( ) ____
____
____

_. Biological Parameters

( ) Obtain a visual estimate of escapement by conducting foot, boat and/or underwater surveys to obtain counts of active spawners and holding fish by stream section, at time intervals less than the spawner turn-over rate. Derive total population estimates based on estimated total spawning effort and the average time spent per adult on the spawning grounds.

( ) Estimate the size of spawning population by tagging and releasing migrating salmonid adults below the spawning grounds, and by determining tagged:untagged ratios among carcasses available for the species in question over the major portion of the run. Tagging of adults in saltwater should be avoided if possible. Capture adults by beach seining, tangle netting, angling, adult fence, or other method acceptable to Scientific Authority, and tag with numbered Petersen tags color-coded by week (supplied by DFO). Estimate the size of a given spawning population by using the Petersen mark-recapture method; apply the tagging and recovery effort necessary to estimate the study area escapement to within ±25%, at the 95% level of confidence (W.E. Ricker, Canadian Journal of Fisheries and Aquatic Sciences Bulletin 191). In estimating effort, the bidder should recognize that tag recovery rates in many previous studies were quite low. The total population estimate should take into account sources of error and bias.

( ) Conduct a minimum of three helicopter flights, with one at the time of peak spawning, to obtain an independent visual estimate of salmonid spawners and distribution, particularly in cases where distances preclude coverage of the entire watershed on foot.

( ) Determine migration timing of ____________________________ adults (and incidental species) by means of daily counts of fish passing the _________________ fishway, by counting unsuccessful and successful jumpers at the falls at set times during the day, and by inspections at least twice weekly of downstream and estuarine areas.

( ) Migrants should not be delayed in their passage past a fence more than two days.

( ) Record the distribution and abundance of spawning salmon in carcass recovery surveys. Rate subjectively the spawning and holding activity per river section as high, medium, low or scattered and transfer the information to large-scale topographic maps for early, peak and late stages of spawning; determine from above data the timing of river entry, spawning period (start, peak, end) and die-off period for the species in question.

( ) Conduct a continuous carcass recovery survey at approximately weekly intervals during the start of the spawning run and 2-3 times per week throughout the die-off period; use division points established in 198_, establish distinct stream sections for dead recovery so that the division points can be found for future studies; carry out the surveys on foot, by downstream swimming or by river boat; cut in half all recovered carcasses to prevent recounting in subsequent surveys.

( ) Sample carcasses for sex and age composition; length distribution (postorbital-hypural for live and dead fish)[a]; weight, fecundity and egg retention in dead females; record any significant external marks (e.g. missing fins, hook scars); in determining the length and age composition, target for a sample size of 100 fish of each sex, and maintain a measurement accuracy of ± 0.5 cm.

( ) Record flesh color of all fresh chinook carcasses recovered.

( ) For age determination collect scales preferably from live fish to minimize scale resorption; for chum and sockeye salmon remove 2 scales from the left side above the lateral line in the area between the dorsal and adipose fins; for chinook and coho remove 10 scales per fish, 5 from each side from above and below the lateral line; the Department of Fisheries and Oceans will provide scale books and personnel for interpreting the scales.

( ) Collect _________ otoliths for age determination from _____________.

( ) Determine fecundity by total egg count on all dead, unspawned female salmon found and on females taken during tagging operations, over the available size range; obtain postorbital-hypural length and scale data for each female sampled; the number of females sacrificed should be restricted to 5-10 individuals, depending on the size of the escapements.

( ) Estimate potential egg deposition of salmon populations under study by using the fecundity data, the number of females in the population, and the mean percent egg retention.

( ) To supplement carcass recovery data, live sampling of migrant ________ ______ from _________________________ is to be attempted. Sampling rate is to be set at 10% of the previous day's run (up to a maximum of 10 fish/species). The fish are to be captured using _______________ ____________ DFO will provide ___________________________________

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[a] Dead fish to be measured using a postorbital-hypural stick made to DFO specifications (drawings available from Scientific Authority); live fish either should be anaesthetized, or a tape measure should be used.

________________. If necessary to prevent damage, fish are to be anaesthetized by accepted methods, and sampled as in Section ___ (substitute degree of maturity - e.g. bright, mature, green, ripe, spawned out - for fecundity and egg retention). Document all mortalities due to sampling.

( ) The successful contractor will arrange with G. Hoskins of Diagnostic Services, Pacific Biological Station, Nanaimo, for sampling and/or shipment of adult specimens for determination of endemic disease characteristics of the population. Sampling frequency and intensity, including contingency plans for pre-spawning mortalities, are to be determined in consultation with Mr. Hoskins after the award of the contract.

( ) Determine average egg diameters by measuring 10 eggs in line, taken only from mature ripe fish (live or fresh dead). Eggs to be taken from ripe females over the full size range and water-hardened for 1.5 hours prior to measurement.

( ) Note all incidental observations of rearing juvenile salmon, competitors, predators, etc.

( ) ____

____

____

_. Reporting

( ) Submit monthly brief progress reports containing summaries of current data and any significant findings.

( ) Submit two copies of a draft report by _______________, 19__ presented in a clear and comprehensive manner, which outlines the methods employed and results obtained, and discusses the latter in relation both to prior relevant studies and to proposed enhancement measures (eg. recommend access routes and methods and locations of capture and holding of broodstock).

( ) Submit the camera-ready originals and one bound copy of the final approved report by ________, 19__.

( ) The report shall also include a watershed description (physical features, climate, land use, access maps, etc.) and a background on the salmonid populations in question based on available records.

( ) Raw data and/or summaries are to be included in a separate, bound appendix (two copies). Due to publication costs, DFO will not publish appendices.

( ) Temperature data taken beyond the period of adult field work is to be reported separately by means of monthly summary forms, which are to be received by ______________, 19__.

( ) ____
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____

PART . LIMNOLOGICAL SURVEY OF ____________

OBJECTIVES

( ) To determine and report on the suitability of water from ____________ Lake for use in ____
____
____
____
____

_. SCHEDULE

Mobilization to begin by __________________, 19__. Field work within the period _______________, 19__ to __________________, 19__. Draft report to be received by Scientific Authority by ____________________, 19__; final report submitted by _____________, 19__.

_. METHODS

The lake is to be surveyed at least four times within the field work period, at times of the year considered critical in determining the seasonal limnological characterization of the lake. The following tasks are to be undertaken during the surveys:

( ) Determine lake morphometry by accepted methods, with special emphasis given to the outlet area.

( ) Establish permanent sampling station(s) for use in the tasks outlined below.

( ) Record lake surface temperature (calibrated daily max/mean/min) and level (photograph and bench mark staff gauge) throughout study period. Describe all staff gauge installations in sufficient detail to allow reinstallation in future studies.

( ) Water quality samples (full series - see following tables) are to be taken from the surface and at 2 m and 10 m, as near to the outlet area as possible. Sampling to be coordinated such that shipment to the DFO Cypress Creek Lab (4195 Marine Drive, West Vancouver) is complete within 48 hours, and will arrive at the lab before noon on Friday (of a normal work week). Samples to be packed in ice in coolers for shipment. All analyses will be done by DFO.

( ) Determine by accepted means, calibrated temperature and oxygen profiles to a minimum of 10 m, as near to the outlet as possible and at the deepest point of the lake.

( ) Take and analyze plankton/algae samples using vertical net hauls from 2 m and 10 m. Identify all species taken, and determine abundances using accepted methods.

( ) During warm-weather visit(s), set overnight gill nets and/or other accepted capture methods to sample trout and other species for endemic disease organisms (particularly ______). Arrangements are to be made with G. Hoskins of Diagnostic Services, Pacific Biological Station, Nanaimo, for sampling and shipment of specimens. Test trapping may be attempted in earlier visits.____

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____

_. Reporting

( ) A progress report (including DFO water quality analytical results) is to be submitted to the Scientific Authority within one month of the completion of each survey trip.

( ) A draft report is to be submitted by _______________, 19__; the final report is due no later than _____________________, 19__. The final report shall outline the methods employed and results obtained, and discuss the latter in view of the stated objective.

( ) The final report shall include a watershed description (physical features, climates, land use, access maps, etc.) and a background on the salmonid populations in question based on available records.

( ) Raw data and summaries should be included in a separate, bound appendix (two copies).

FORM OF TENDER

Costs should be detailed under the following headings:

A. SCHEDULE OF OPERATIONS

- time period of each phase
- personnel allocations in each phase and total

B. PERSONNEL

- level, number, time, charges (per diem rate), availability

1. Planning and administration
2. Mobilization and reconnaissance
3. Field Program - breakdown by tasks
4. Demobilization
5. Literature review
6. Data analysis
7. Report preparation (includes rewrite time after draft review)

C. EXPENSES

1. Equipment and vehicle rentals, leases and charters
   - including specifications and availability.

2. Materials charged

3. Disbursements
   - including travel, accommodation, shipping, communication, copying and miscellaneous services.

4. Analysis
   a) Laboratory
   b) Data Processing

Notes: (1) DFO may not fund work on all of the streams mentioned, or may require approximately the same work on other streams in the same area. Therefore, the above costs should be separated out by adult and juvenile phase, and by stream and estuary such that costs savings from excluding or adding components to the study are shown.

(2) DFO may wish to retain ________________, and the contractor is to deliver it in satisfactory operating condition to ____________

____

____

(3) It is the contractor's responsibility to obtain Provincial and Federal Sampling permits. For Federal permits, the contractor is to apply by letter to the appropriate Area Manager. The application should include names of crew; name and address of firm; type, species and number of fish to be taken; method and area of catch; and period of study. The contractor also is responsible to ensure that the relevant District Supervisor and Fishery Officers are aware of the intended operation and its subsequent progress.

(4) Where weirs are used that may result in concentrations of adults, the contractor should consult the Fishery Officer as to the need for partial or total stream closures to anglers.

Studies on Pacific Salmon (Oncorhynchus spp.) in Phase I of the Salmond Enhancement Program

Volume II: Data Appendices

B.G. Shepherd, J.E. Hillaby, and R.J. Hutton

Salmonid Enhancement Program
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November 1986

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Fisheries and Oceans Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1–456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457–714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715–924 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

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STUDIES ON PACIFIC SALMON (*Oncorhynchus* spp.) IN PHASE I OF THE SALMONID ENHANCEMENT PROGRAM

VOLUME II: DATA APPENDICES

by

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ABSTRACT

Shepherd, B.G., J.E. Hillaby and R.J. Hutton. 1986. Studies on Pacific salmon *(Oncorhynchus* spp.) in Phase I of the Salmonid Enhancement Program Volume II: DATA APPENDICES. Can. Tech. Rep. Fish. Aquat. Sci. 1482: vii +pp 181-364.

From 1977 to 1984 the New Projects Unit initiated 38 field studies on wild salmon stocks throughout British Columbia, in order to develop biological design criteria for proposed enhancement projects. The purpose of this report is to make the data from these studies more easily available to other users. Pertinent biological data were extracted from the individual field studies, and adjusted where necessary to make the data as consistent as possible for comparative purposes.

Data are presented on migration timing, distribution and abundance of adults and juveniles; spawner characteristics such as sex ratio, age, length at age, fecundity, egg retention rates, flesh colour, and incidence of diseases; and length, weight and condition factors of juveniles. Physical characteristics of stream habitat important for spawning and rearing of wild salmon are also reviewed. These data are tabulated by stream and stock in Volume II; Volume I overviews the information by species and region, and provides perspective on factors which may have affected the findings.

RÉSUMÉ

Shepherd, B.G., J.E. Hillaby and R.J. Hutton. 1986. Studies on Pacific salmon *(Oncorhynchus* spp.) in Phase I of the Salmonid Enhancement Program Volume II: DATA APPENDICES. Can. Tech. Rep. Fish. Aquat. Sci. 1482: vii + pp 181-364.

De 1977 à 1984, la section des nouveaux projets a amorcé 38 études sur le terrain portant sur des stocks de saumons sauvages. Ces études effectuées à l'echelle de la Colombie-Britannique ont pour objectif la détermination de critères biologiques de conception pour des projets de mise en valeur. Le rapport vise à rendre les données de ces études plus accessibles aux autres utilisateurs. Les données biologiques pertinentes ont été tirées des rapports et ajustées selon les besoins afin de les rendre les plus cohérentes possibles aux fins de comparaison.

Les données portent sur le moment des migrations, la distribution et l'abondance des adultes et des juvéniles, certaines caractéristiques des geniteurs comme le sex ratio, l'âge, la longueur selon l'âge, la fécondité, le taux de rétention des oeufs, la couleur de la chair et l'incidence des maladies, de même que sur la longueur, le poids et la condition des juvéniles. On traite aussi des caractéristiques physiques des habitats en cours d'eau importants pour le frai et la croissance des saumons sauvages. Les données sont présentées sous forme de tableaux, par cours d'eau et stocks, dans le Volume II. Le Volume I contient les renseignements sur les espèces et les régions et met en perspective les facteurs qui ont pu influer sur les résultats.

APPENDIX C-1

Comparison of TIMING DATA Obtained During New Projects (NP) Studies with Stream File (SF) Information

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New Projects (NP) data are extracted directly from the source reports and usually are more specific than that given by Stream File (SF) reports. Often, NP data are in agreement with SF information but NP start and end of run timing dates are, respectively, prior to and after those indicated by SF information. This may be a reflection of the greater effort made by personnel gathering NP data for certain species. The greatest drawback to the NP data is that project initiation and termination dates usually fall well within the boundaries of run timing, resulting in little concrete data being presented on the initial immigration or final die-off periods.

SF (avg.) indicates average run timing for the previous ten years.

COMPARISON OF CHINOOK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
SOUTH COAST - Cont'd												
Mussel Ck.	1981	NP	Boat Surveys	before July 12	-	-	Sept. 15	Oct. 1	Oct. 15	-	-	-
		SF	Included in Klinaklini R.									
	1983	NP	Fence, Streamside & Aerial Surveys	July 20	Aug. 24	Sept. 13	Aug. 25	Sept. 25	Oct. 10	Sept. 23	Oct. 15	Oct. 22
		SF										
		SF (Avg)	Included in Klinaklini R.									
Klinaklini R.	1983	NP	Aerial and Foot Surveys	-	-	-	Aug. 20-22	Sept. 10-15	Sept. 25-28	Sept. 10	Sept. 20-25	Oct. 1-12
		SF			-	-				-	-	-
		SF (Avg)		May	-	-	July	late Sept.	Oct.	-	-	-
Ahnuhati R.	1981	NP	Aerial, Float, Foot Surveys	before July 28	-	-	Aug. 15	Sept. 1	Sept. 15	-	-	-
		SF	-	-	-	-	-	-	-	-	-	-
		SF (Avg)	-	-	-	-	-	-	-	-	-	-
	1983	NP	Aerial & Foot Surveys	Aug. 1-5	Aug. 10-15	Sept. 5	Aug. 20	Sept. 7	Sept. 25	Sept. 5-10	Sept. 15-20	Sept. 30
		SF	-	-	-	-	-	-	-	-	-	-
		SF (Avg)	-	-	-	-	-	-	-	-	-	-
Nitinat R.	1979	NP	Foot Surveys	late Aug.	Aug. 20	-	Sept. 20	early Oct.	Nov. 14	-	-	-
		SF		Sept.	-	-	Oct. 15	Nov. 10	Dec.	-	-	-
		SF (Avg)			-	-				-	-	-
FRASER R., N.B.C. and YUKON												
Holmes R.	1981	NP	Boat, Float, Aerial Surveys	-	early Aug.	-	-	late Aug.	mid-Sept.	-	-	-
		SF		late July	-	-	mid-Aug.	late Aug.	early Sept.	-	-	-
		SF (Avg)		early Aug.	-	-	mid-Aug.	late Aug.	early Sept.	-	-	-
Morkill R.	1981	NP	Boat, Float, Aerial Surveys	-	-	early Aug.	-	early Sept.	late Sept.	-	-	-
		SF		Aug. 1	-	-	Aug. 20	Aug. 25	Sept. 2	-	-	-
		SF (Avg)		early Aug.	-	-	mid-Aug	early Sept.	late Sept.	-	-	-
Torpy R.	1981	NP	Boat, Float, Aerial Surveys	-	-	late July	-	late Aug.	-	-	-	-
		SF		July 25	-	-	Aug. 7	Aug. 16	Aug. 25	-	-	-
		SF (Avg)		late July	-	-	-	late Aug.	-	-	-	-

COMPARISON OF CHINOOK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
NORTH COAST												
Morice R.	1978	NP	Aerial & Foot Surveys	-	-	-	early Sept.	-	-	-	-	-
		SF			-	-				-	-	-
	1980	NP	Aerial & Foot Surveys	-	-	-	early Sept.	-	-	-	-	-
		SF										
		SF (Avg)		-	-	-	July-early Sept.	Aug-mid Sept.	mid-Sept. - mid-Oct.	-	-	-
Kitlope R.	1981	NP	Aerial, Boat Foot Surveys	before mid-July	-	-	Aug. 10	-	-	Aug. 21	-	late Sept.
		SF		June	-	-	mid-July	late July	early Sept.	-	-	-
		SF (Avg)		June	-	-	July	Aug.	Sept.	-	-	-
Gamsby R.	1981	NP	Aerial, Boat, Foot Surveys	-	-	-	1st observ. Aug. 21	-	-	-	-	-
		SF	Included in Kitlope R.									
		SF (Avg)	Included in Kitlope R.									
Tezwa R.	1981	NP	Aerial, Boat, Foot Surveys	-	-	-	Aug. 12	-	-	-	-	mid Sept.
		SF	Included in Kitlope R.									
		SF (Avg)	Included in Kitlope R.									
Kemano R. (incl. tribs.)	1979	NP	Aerial & Foot Surveys	-	Aug. 23-30	Sept. 5	-	-	-	Aug. 15	-	Sept. 25
		SF			-	-						
		SF (Avg)		June	-	-	mid-July	late July	mid August	-	-	-
Kwatna R.	1983	NP	Foot, Float, Boat, Helicopter	mid June	-	-	mid Aug.	late Aug.	early Sept.	late Aug.	early Sept.	mid Sept.
		SF			-	-				-	-	-
		SF (Avg)		July	-	-	Aug.	Aug.	Sept.	-	-	-
SOUTH COAST												
Kakweiken R.	1981	NP	Fishway Survey	before July 7	-	July 27	-	-	-	-	-	-
		SF		July	-	-	Aug.	Oct.	Nov.	-	-	-
		SF (Avg)		July	-	-	Sept.	late Sept.	-	-	-	-

COMPARISON OF CHINOOK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
FRASER R., N.B.C. and YUKON - Cont'd												
Silm Ck.	1980	NP	Aerial & Boat Surveys	Aug. 7	-	-	Aug. 7-17	Aug19-Sept6	Sept. 14	Sept. 3	-	Sept. 14
		SF		early Aug.	-	-	Aug. 29	Sept. 5-7	Sept. 15	-	-	-
	1981	NP	Boat, Float, Aerial Surveys	-	-	mid-Aug.	-	early Sept.	late Sept.	-	-	-
		SF		Aug. 10	-	-	Aug. 25	Aug. 29	Sept. 6	-	-	-
		SF (Avg)		mid-Aug.	-	-	late Aug.	early Sept.	late Sept.	-	-	-
Bowron R.	1980	NP	Aerial & Boat Surveys	July 30	-	-	Aug. 15	Aug20-Sept1	Sept. 15	Aug. 15	-	Sept. 20
		SF		Aug. 1	-	-	Aug. 20	Sept. 1	Sept. 12	-	-	-
		SF (Avg)		early Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
Willow R. (Incl. Wansa Ck.)	1980	NP	Aerial and Boat Surveys	July28-Aug7	-	-	Aug. 7-17	Aug19-Sept6	Sept. 2-14	Aug20-Sept3	-	Sept. 14-17
		SF		early Aug.	-	-	Aug. 18	Aug. 23-25	Aug. 29	-	-	-
		SF (Avg)		mid-Aug.	-	-	mid-Aug.	late Aug.	-	-	-	-
Stuart R.	1980	NP	Boat Survey	-	-	-	Aug27-Sept1	Sept. 16-17	Oct. 2	-	-	-
		SF		late Aug.	-	-	Sept. 5-8	Sept. 13	Sept. 20	-	-	-
		SF (Avg)		late Aug.	-	-	early Sept.	mid-Sept.	late Sept.	-	-	-
Nechako R.	1979	NP	Boat, Float, Aerial Surveys	-	-	Sept. 3	Sept. 12	Sept. 20	Oct. 1	Sept. 5	Oct. 4	Oct. 15
		SF		mid-Aug.	-	-	-	Sept. 8-22	-	-	-	-
		SF (Avg)		late Aug.	-	-	-	mid-Sept.	-	-	-	-
West Road (Blackwater) R.	1980	NP	Aerial Survey	early Aug.	late Aug.	mid-Sept.	-	before Sept9	-	-	-	Sept. 30
		SF		Aug. 1	-	-	Aug. 22	Aug. 31	Sept. 8	-	-	-
		SF (Avg)		early Aug.	-	-	mid Aug.	late Aug.	mid-Sept.	-	-	-
Nazko R.	1980	NP	Aerial Survey	early Aug.	late Aug.	mid-Sept.	-	before Aug29	-	-	-	Sept. 15
		SF		Included in West Road R.								
		SF (Avg)		Included in West Road R.								
Cottonwood R.	1980	NP	Aerial Survey	-	Sept. 1	-	-	Sept. 1	Sept. 7	-	-	Sept. 15
		SF		Aug. 5	-	-	Aug. 16	Aug. 25	Sept. 4	-	-	-
		SF (Avg)		early Aug.	-	-	late Aug.	late Aug.	early Sept.	-	-	-

COMPARISON OF CHINOOK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
FRASER R., N.B.C. and YUKON - Cont'd												
Horsefly R.	1979	NP	Boat, Float, Aerial Surveys	Aug. 9	-	-	Aug. 23	Sept. 2	Sept. 8	-	Sept. 14	Sept. 27
		SF		Aug. 11	-	-	Aug. 24	Sept. 2	Sept. 11	-	-	-
	1980	NP	Float, Aerial Surveys	July 16	Aug. 12	Aug. 23	Aug. 22	Sept. 1	Sept. 10	Sept. 7	Sept. 20	Sept. 30
		SF		Aug. 13	-	-	Aug. 20	Aug. 30	Sept. 8	-	-	-
		SF (Avg)		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
McKinley Ck.	1980	NP	Aerial Surveys	July 31	Aug. 12	Aug. 23	-	Sept. 1-10	-	Sept. 7	Sept. 20	Sept. 30
		SF					Included in	Horsefly R.				
		SF (Avg)					Included in	Horsefly R.				
Quesnel R.	1979	NP	Boat, Float, Aerial Surveys	-	-	Aug. 29	Sept. 20	Sept. 28	Oct. 10	Sept. 11	Oct. 10	Nov. 1
		SF		Aug. 18	-	-	Sept. 10	Sept. 29	Oct. 14	-	-	-
	1980	NP	Float & Aerial Surveys	Aug. 7	Sept. 7	Sept. 27	Aug. 26	Sept. 21	Oct. 10	Sept. 16	Oct. 2	Oct. 27
		SF		Aug. 16	-	-	Sept. 14	Sept. 28	Oct. 8	-	-	-
		SF (Avg)		early Sept.	-	-	mid-Sept.	early Oct.	mid-Oct.	-	-	-
Eagle R.	1981	NP	Float, Foot, Boat, Aerial Surveys	Aug. 17	Sept. 15	Sept. 20	Sept. 11	Sept. 18	Sept. 25	Sept. 16	Sept. 30	Oct. 3
		SF		Aug. 1	-	-	Sept. 5	Sept. 25	Oct.	-	-	-
		SF (Avg)		mid-Aug.	-	-	mid-Sept.	late Sept.	Oct.	-	-	-
Salmon R.	1981	NP	Float, Foot, Boat, Aerial Surveys	Aug. 10	Sept. 1	Sept. 11	Aug. 29	Sept. 10	Sept. 17	Sept. 10	Sept. 20	Sept. 25
		SF		July 15	-	-	Aug. 15	Sept. 15	Oct. 1	-	-	-
		SF (Avg)		mid-July	-	-	early Sept.	mid-Sept.	late Sept.	-	-	-
Adams R. (lower)	1981	NP	Float, Boat, Aerial, Foot Surveys	Sept. 10	Oct. 1	Oct. 7	Sept. 21	Oct. 6	Oct. 14	Sept. 30	Oct. 11	Oct. 18
		SF		Sept. 10	-	-	Sept. 25	Oct. 10	Oct. 31	-	-	-
		SF (Avg)		mid-July	-	-	mid-Sept.	early Oct.	late Oct.	-	-	-

COMPARISON OF CHINOOK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
FRASER R., N.B.C. and YUKON - Cont'd												
South Thompson R.	1981	NP	Float, Boat, Aerial, Foot Surveys	Sept. 15	Oct. 4	Oct. 10	Sept. 17	Oct. 7	Oct. 16	Oct. 1	Oct. 14	Nov. 10
		SF		Aug.	-	-	Sept. 20	Oct. 10	Oct. 31	-	-	-
		SF (Avg)		Aug.	-	-	late Sept.	early Oct.	late Oct.	-	-	-
Finn Ck.	1981	NP	Foot, Fence Surveys	July 21	Aug. 4	Aug. 20	July 24	Aug. 8	Aug. 24	Aug. 4	Aug. 19	Sept. 1
		SF		July 22	-	-	July 30	Aug. 14	early Sept.	-	-	-
		SF (Avg)		late July	-	-	early Aug.	mid-Aug.	early Sept.	-	-	-
Raft R.	1981	NP	Float, Foot Surveys, Carcass Examination	Aug. 13	Sept. 2	Sept. 13	Aug. 23	Sept. 5	Sept. 19	Aug. 29	Sept. 12	Sept. 24
		SF		Aug. 14	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
		SF (Avg)		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
North Thompson R.	1981	NP	Foot Surveys, Carcass Examination	Aug. 22	Sept. 9	Sept. 24	Aug. 28	Sept. 15	Oct. 2	Sept. 2	Sept. 24	Oct. 10
		SF		late Aug.	-	-	early Sept.	mid-Sept.	late Sept.	-	-	-
		SF (Avg)		mid-Aug.	-	-	early Sept.	mid-Sept.	early Oct.	-	-	-

COMPARISON OF COHO TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
NORTH COAST												
Mathers Ck.	1978	NP	Foot Surveys	before Sept12	-	-	Oct. 20	-	after Nov10	-	-	-
		SF		Aug. 27	-	-	Oct. 18	Nov. 8	-	-	-	-
	1979	NP	Float, Foot Surveys	before Sept12	Nov. 8	-	-	-	-	-	-	-
		SF		mid Sept.	-	-	early Oct.	-	Nov.	-	-	-
		SF (Avg)		mid Sept.	-	-	July	Aug.	Sept.	-	-	-
Kitlope R	1981	NP	Aerial, Boat, Foot Surveys	Aug. 26	-	-	late Oct.	early Nov.	mid-Dec.	-	-	-
		SF		Aug.	-	-	Sept.	Oct.	Nov.	-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Oct.	early Nov.	-	-	-
Kwatna R.	1983	NP	Foot, Float, Boat, Helicopter	early Aug.	-	-	late Oct.	Nov.	Dec.	Nov.	Nov./Dec.	Dec./Jan.
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Oct.	Dec.	-	-	-
Nootum R.	1983	NP	Foot, Boat Helicopter	Aug.	-	-	Sept.	Oct.	Dec.	Nov.	Nov./Dec.	Dec./Jan.
		SF			-	-				-	-	-
		SF (Avg)			-	-				-	-	-
SOUTH COAST												
Kakwalken R.	1981	NP	Counting Fence	before July11	Aug. 19	Sept. 12	-	-	-	-	-	-
		SF		July		-	Sept.	Oct.	Dec.	-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Oct.	Nov.	-	-	-
Glendale/ Tom Browne Cks.	1981	NP	Foot Surveys	Aug. 26	-	-	after Oct24	-	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)		late Aug.	-	-	Sept.	Oct.	Oct.	-	-	-
Mussel Ck.	1981	NP	Foot Surveys	Aug. 20	-	-	Oct. 20	Oct. 30	-	-	-	-
		SF		Included in Klinaklini River								
	1983	NP	Fence, Foot, Aerial Surveys	July 20	Aug. 20	Oct. 20	Oct. 15	Oct. 25	-	-	-	-
		SF		Included in Klinaklini River								
		SF (Avg)		Included in Klinaklini River								

COMPARISON OF COHO TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
SOUTH COAST - Cont'd												
Kilnakilni R.	1983	NP	Foot and Aerial Surveys	Oct. 1	Oct. 8	Oct. 25	Oct. 15	Oct. 30	Nov. 15	Oct. 20	Nov. 10	Nov. 30
		SF			-	-				-	-	-
		SF (Avg)		June	-	-	Sept.	Nov.	Dec.	-	-	-
Ahnuhati R.	1981	NP	Foot Surveys	Aug. 28	-	-	after Oct26	-	-	-	-	-
		SF			-	-				-	-	-
	1983	NP	Foot & Aerial Surveys	Aug. 10-20	Oct. 5-10	Oct. 28	-	-	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)			-	-				-	-	-
Franklin R.	1981	NP	Foot Surveys	Oct. 29	-	-	-	-	-	-	-	-
		SF										
		SF (Avg)		Oct.	-	-	Nov.	Nov.	Dec.	-	-	-
Kwalate Ck.	1981	NP	Foot Surveys	before Aug28	-	-	after Oct23	-	-	-	-	-
		SF		Aug.	-	-	Aug.	Sept.	Oct.	-	-	-
		SF (Avg)		July	-	-	Sept.	Oct.	Nov.	-	-	-
Nitinat R.	1979	NP	Foot Surveys	Oct. 14	-	-	Nov. 11	Nov. 15-30	after Nov30	-	-	-
		SF		Oct.	-	-	Nov.	Dec.	Jan.	-	-	-
		SF (Avg)		Oct.	-	-	Oct.	Nov.	Dec.	-	-	-
FRASER R., N.B.C., and YUKON												
Eagle R. (Incl. South Pass Ck.)	1982	NP	Foot Surveys	before Oct20	-	-	Oct. 20-25	Nov. 1-10	Dec. 1-5	Oct. 25-28	Nov. 15-20	Dec. 5-10
		SF		Oct. 1	-	-	Oct. 20	Nov. 10	Dec.	-	-	-
		SF (Avg)		early Oct.	-	-	late Oct.	mid-Nov.	Dec.	-	-	-
Salmon R. (Incl. Boleen Ck.)	1982	NP	Foot Surveys	-	-	-	Oct. 20-25	Nov. 1-5	Nov. 25-30	Oct. 25-29	Nov. 15-20	Nov. 30
		SF		Sept. 20	-	-	Oct. 5	Nov. 1	Dec.	-	-	-
		SF (Avg)		mid-Oct.	-	-	late Oct.	early Nov.	late Nov.	-	-	-
Adams R. (lower) (Incl. Hiuihill, Nikwikwaia, Sinmax Cks.)	1982	NP	Foot & Aerial Surveys	-	-	-	Oct. 20-25	Nov. 1-15	Nov. 15-30	Oct. 27-30	Nov. 10-20	Nov. 25-30
		SF		Oct. 1	-	-	Nov. 1	Nov. 15	Nov. 30	-	-	-
		SF (Avg)		mid-Oct.	-	-	late Oct.	mid-Nov.	Dec.	-	-	-

COMPARISON OF COHO TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
FRASER R., N.B.C., and YUKON - Cont'd												
Adams R. (upper) (Incl. Momich R., Cayenne Ck.)	1982	NP	Foot Surveys	-	-	-	Oct. 20-30	Nov. 1-5	Nov. 20-25	Nov. 1-5	Nov. 1-15	Nov. 20-30
		SF		early Nov.	-	-	mid-Nov.	late Nov.	-	-	-	-
		SF (Avg)		mid-late Oct.	-	-	early Nov.	mid-Nov.	late Nov.	-	-	-
Albreda R.	1982	NP	Foot Surveys	early Nov.	-	-	mid-Nov.	early Dec.	late Dec.	-	mid-late Dec.	-
		SF	Foot Surveys	mid Oct.	-	-	early Nov.	Nov. 20	early Dec.	-	-	-
		SF (Avg)		early Oct.	-	-	late Oct.	early Nov.	late Nov.	-	-	-
Blue R.	1982	NP	Foot Surveys	early-mid Nov	-	-	late Nov. - early Dec.	late Dec. - early Jan.	mid-Jan.	-	early mid-Jan.	-
		SF	Foot, Boat Survey	mid-Oct.	-	-	early Nov.	Nov. 20	early Dec.	-	-	-
		SF (Avg)		late Oct.	-	-	early Nov.	mid-Nov.	early Dec.	-	-	-
Lion Ck.	1982	NP	Foot Surveys	mid-Sept.	-	-	late Sept.	early-mid Nov.	mid-late Jan.	-	late Nov.	-
		SF	Foot Surveys	mid-Oct.	-	-	early Nov.	mid-Nov.	early Dec.	-	-	-
		SF (Avg)		mid-Oct.	-	-	late Oct.	mid-Nov.	late Nov.	-	-	-
Wire Cache Ck.	1982	NP	Foot Surveys	-	-	-	-	-	mid-Nov.	-	-	-
		SF	Foot Surveys	mid-Oct.	-	-	late Oct.	early Nov.	late Nov.	-	-	-
		SF (Avg)	no records previous to 1982									
Lemieux Ck.	1982	NP	Foot Surveys	mid-Oct. - late Nov.	-	-	mid-Nov. - mid-Dec.	late Nov. - early Dec.	late Dec.	-	mid-Dec.	-
		SF	Foot Surveys	late Oct.	-	-	early Nov.	Nov. 20	early Dec.	-	-	-
		SF (Avg)		late Oct.	-	-	mid-Nov.	late Nov.	mid-Dec.	-	-	-
Barriere R.	1982	NP	Foot Surveys	-	-	-	-	-	mid-Jan.	-	-	-
		SF	Foot Surveys	mid-Oct.	-	-	early Nov.	Nov. 20	early Dec.	-	-	-
		SF (Avg)		mid-Oct.	-	-	early Nov.	mid-Nov.	early Dec.	-	-	-
Louis Ck. (Incl. Christian Ck.)	1982	NP	Foot Surveys	late Aug.	-	-	-	mid-Nov.	-	-	-	-
		SF	Foot Surveys	early Oct.	-	-	late Oct.	early Nov.	late Nov.	-	-	-
		SF (Avg)		mid-Oct.	-	-	late Oct.	mid-Nov.	early Dec.	-	-	-
Coldwater R.	1982	NP	Foot Surveys	-	-	-	Oct. 20-30	Nov. 5-10	Nov. 25-30	Nov. 10-15	Nov. 15-25	Dec. 5
		SF		Oct.	-	-	Nov. 10	Nov20-Dec1	Dec.	-	-	-
		SF (Avg)		Oct.	-	-	late Oct.	mid-Nov.	late Nov.	-	-	-

COMPARISON OF CHUM TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
NORTH COAST												
Mathers Ck.	1978	NP	Float, Foot Surveys	-	-	-	Sept. 22	Oct. 17-20	3rd week Oct	-	-	-
		SF		Sept. 15	-	-	Sept. 17	Oct. 15	Oct. 30	-	-	-
	1979	NP	Foot Surveys	Oct. 1	-	-	-	-	-	-	-	-
		SF		early Oct.	-	-	Oct.	late Oct.	early Nov.	-	-	-
		SF (Avg)		-	-	-	early Sept.	late Sept.	late Sept.	-	-	-
Kitlope R.	1981	NP	Aerial, Boat, Foot Surveys	-	-	-	mid-Aug.	-	-	-	-	late Sept.
		SF		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
		SF (Avg)			-	-				-	-	-
Gamsby R.	1981	NP	Aerial, Boat, Foot Surveys	-	-	-	early Aug.	early Sept.	mid-Sept.	mid-Aug.	mid-Sept.	late Sept.
		SF	Included in Kitlope R.									
		SF (Avg)	Included in Kitlope R.									
Kemano R.	1979	NP	Aerial, Foot Surveys	-	-	-	before Aug9	-	-	Aug. 16	Aug. 27 - Sept. 14	Sept. 25
		SF		late July	-	-	early Aug.	late Aug.	early Sept.	-	-	-
		SF (Avg)		late July	-	-	early Aug.	late Aug.	mid-Sept.	-	-	-
Kwatna R.	1983	NP	Foot, Float, Boat, Helicopter	mid July	-	-	early Aug.	late Aug.	early Oct,	mid Aug.	early Sept.	mid Oct.
		SF			-	-				-	-	-
		SF (Avg)		early Aug.	-	-	Aug.	Aug.	late Sept.	-	-	-
Quatlena R.	1983	NP	Foot, Helicopter	mid Aug.	-	-	late Aug.	mid Sept.	late Sept.	mid Sept.	late Sept.	mid Oct.
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	Aug.	Aug.	Sept.	-	-	-
Nootum R.	1983	NP	Foot, Boat, Helicopter	early Aug.	-	-	early Sept.	mid Sept.	late Sept.	mid Sept.	late Sept.	early Oct.
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	mid Aug.	late Aug.	Oct.	-	-	-
SOUTH COAST												
Kakweiken R.	1981	NP	Aerial, Foot Surveys	July 21	Aug. 25-28	-	-	-	-	-	-	-
		SF		Sept.	-	-	Sept.	Late Sept.	Oct.	-	-	-
		SF (Avg)			-	-				-	-	-

COMPARISON OF CHUM TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
SOUTH COAST - Cont'd												
Glendale/ Tom Browne Cks.	1981	NP	Foot Surveys	Sept. 20	-	-	Sept. 20	Oct. 15	Nov. 1	-	-	-
		SF			-	-				-	-	-
	1983	NP	Aerial, Foot Surveys	Sept. 5-10	Oct. 1-5	Oct. 15	Sept.10-15	Oct. 10-15	Nov. 1-5	Sept. 20	Oct. 25	Nov. 10-15
		SF										
		SF (Avg)		Sept.	-	-	Oct.	Oct.	Nov.	-	-	-
Mussel Ck.	1981	NP	Foot Surveys	Oct. 7	-	-	Oct. 7	Oct. 20	-	-	-	-
		SF		Included in Klinaklini River								
	1983	NP	Foot Surveys	Oct. 7	-	-	Oct. 7	Oct. 20	-	-	-	-
		SF		Included in Klinaklini River								
		SF (Avg)		Included in Klinaklini River								
Klinaklini R.	1983	NP	Aerial & Foot Surveys	Sept. 20-25	-	-	Oct. 1-15	Nov. 1-5	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)		Sept.	-	-	Oct.	Nov.	Nov.	-	-	-
Ahnuhati R.	1981	NP	Foot Surveys	July 23	- -	- -	July 28	Aug. 3	Sept. 15	-	-	after mid-Oct.
		SF								-	-	-
	1983	NP	Aerial, Foot Surveys	July 20-25	Aug. 10-15	Aug. 20	Aug. 1	Aug. 20-22	Sept. 10	Aug. 12	Sept. 2-5	Sept. 23
		SF			-	-				-	-	-
		SF (Avg)			-	-				-	-	-
Sucwoa R.	1978	NP	Foot Surveys	-	-	-	Sept. 24	Oct. 13	Nov. 6	Oct. 3	Oct. 22	Nov. 15
		SF						no report				
		SF (Avg)		-	-	-	Sept.	Oct.	Nov.	-	-	-
Canton Ck.	1978	NP	Foot Surveys	-	-	-	Sept. 24	Oct. 13	Oct. 30	Oct. 3	Oct. 22	Nov. 8
		SF		Sept.	-	-	Sept.	Oct.	Nov.	-	-	-
		SF (Avg)		Sept.	-	-	Sept.	late Oct.	late Nov.	-	-	-
Conuma R.	1978	NP	Foot Surveys	-	-	-	Sept. 7	Oct. 5	Oct. 26	Sept. 20	Oct. 18	Nov. 8
		SF		Sept.	-	-	Sept.	Sept.	-	-	-	-
		SF (Avg)		Sept.	-	-	Oct.	Nov.	Dec.	-	-	-
Tlupana R.	1978	NP	Foot Surveys	-	-	-	Sept. 16	Oct. 5	Oct. 15	Sept. 25	Oct. 14	Oct. 24
		SF		Sept.	-	-	Sept.	Oct.	Nov. 30	-	-	-
		SF (Avg)		Sept.	-	-	Sept.	Oct.	Nov.	-	-	-

COMPARISON OF CHUM TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
						SOUTH COAST - Cont'd						
Deserted Ck	1978	NP	Foot surveys	-	-	-	Sept. 30	Oct. 27	late Nov.	Oct. 9	Nov. 5	early Dec.
		SF		Sept.	-	-	Sept.	Oct. 26	Nov. 30	-	-	-
		SF (Avg)		Sept.	-	-	Sept.	Oct.	Nov.	-	-	-
Nitinat R.	1979	NP	Foot Surveys	-	-	-	Sept. 26	Oct28-Nov20	Nov. 27	-	-	-
		SF		Oct. 15	-	-	Oct. 31	Nov.	Nov.	-	-	-
		SF (Avg)		early Oct.	-	-	mid-Oct.	early Nov.	Nov.	-	-	-
Little Qualicum R.	1978	NP	Fence, Foot Surveys	-	late Oct. - mid-Nov.	-	early Nov.	Nov. 4-21	late Dec.	-	-	-
		SF		Aug.	-	-	Sept.	Oct.	Dec.	-	-	-
		SF (Avg)		early Oct.	-	-	Oct.	Nov.	late Dec.	-	-	-

COMPARISON OF SOCKEYE TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION			SPAWNING			DIE-OFF		
				START	PEAK	END	START	PEAK	END	START	PEAK	END
NORTH COAST												
Tezwa R.	1981	NP	Aerial, Boat, Foot Surveys	before July18	-	-	Aug. 15	early Sept.	late Sept.	Aug. 20	mid-Sept.	early Oct.
		SF	Included in Kitlope R.									
		SF (Avg)	Included in Kitlope R.									
Kalitan Ck.	1981	NP	Aerial, Boat, Foot Surveys	before July18	-	-	Aug. 15	early Sept.	late Sept.	Aug. 20	mid-Sept.	early Oct.
		SF	Included in Kitlope R.									
		SF (Avg)	Included in Kitlope R.									
Kwatna R.	1983	NP	Foot, Float, Boat, Helicopter	mid Aug.	-	-	mid Sept.	early Oct.	mid Oct.	late Sept.	mid Oct.	late Oct.
		SF			-	-				-	-	-
		SF (Avg)		-	-	-	-	-	-	-	-	-
SOUTH COAST												
Kakweiken R.	1981	NP	Fishway Surveys	July 15	July 27	Aug. 29	-	-	-	-	-	-
		SF		July	-	-	Aug.	Sept.	Oct.	-	-	-
		SF (Avg)		July	-	-	Sept.	late Sept.	-	-	-	-
Glendale/ Tom Browne Cks.	1981	NP	Foot Surveys	-	-	-	-	-	Oct. 3	-	-	-
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	Sept.	-	-	-	-	-
Mussel Ck.	1981	NP	Foot Surveys	Sept. 1	-	-	Sept. 30	-	-	-	-	-
		SF	Included in Klinaklini River									
	1983	NP	Fence, Aerial, Foot Surveys	Aug. 22	Sept. 10	-	Sept. 18	Sept. 28	-	-	-	-
		SF	Included in Klinaklini River									
		SF (Avg)	Included in Klinaklini River									
Klinaklini R.	1983	NP	Aerial, Foot Surveys	-	-	-	-	Oct. 1-5	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Oct.	Oct.	-	-	-
Ahnuhati R.	1981	NP	Foot Surveys	Sept. 16	-	-	Sept. 8	-	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)			-	-				-	-	-

COMPARISON OF SOCKEYE TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION START	IMMIGRATION PEAK	IMMIGRATION END	SPAWNING START	SPAWNING PEAK	SPAWNING END	DIE-OFF START	DIE-OFF PEAK	DIE-OFF END
SOUTH COAST - Cont'd												
Nitinat R.	1979	NP	Foot Surveys	Sept. 9-15	-	Nov. 4-10	-	-	-	-	-	-
		SF	no reports									
		SF (Avg)	no reports									
FRASER R., N.B.C. and YUKON												
Bowron R.	1980	NP	Foot Surveys	July 31	-	Aug. 25	-	-	-	-	-	-
		SF		Aug. 3	-	-	Aug. 22	Sept. 1	Sept. 15	-	-	-
		SF (Avg)		early Aug.	-	-	mid-Aug.	late Aug.	early Sept.	-	-	-
Nechako R. (Incl. tribs.)	1979	NP	Foot Surveys	-	early Sept.	-	-	-	-	-	-	-
		SF	no reports									
		SF (Avg)	no reports									
Adams R. (lower)	1981	NP	Foot Surveys	before Sept23	-	-	Sept. 25	-	-	Oct. 2	-	-
		SF		Sept. 15	-	-	Oct. 1	Oct. 20	Oct. 31	-	-	-
		SF (Avg)		mid-Sept.			early Oct.	late Oct.	Nov.	-	-	-
South Thompson R.	1981	NP	Foot Surveys	Aug. 29	-	-	Oct. 1	-	-	Oct. 10	-	late Nov.
	*	SF			-	-				-	-	-
		SF (Avg)		Sept.	-	-	early Oct.	mid-Oct.	Nov.	-	-	-
Finn Ck.	1981	NP	Foot Surveys	-	-	-	Aug. 28	-	-	-	-	-
		SF		-	-	-	-	late Aug.	early Sept.	-	-	-
		SF (Avg)	no reports									
Raft R.	1981	NP	Foot Surveys	Aug. 21	Aug. 22	Sept. 13	Aug. 23	-	-	Aug. 22	-	-
		SF		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
		SF (Avg)		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
North Thompson R.	1981	NP	Foot Surveys	Sept. 23	-	-	-	late Sept.	after Oct.5	-	-	-
		SF		mid-Aug.	-	-	late Aug.	early Sept.	late Sept.	-	-	-
		SF (Avg)		mid-Aug.	-	-	early Sept.	mid-Sept.	early Oct.	-	-	-

* Spawning file report gives an escapement but no timing data.

COMPARISON OF PINK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION START	IMMIGRATION PEAK	IMMIGRATION END	SPAWNING START	SPAWNING PEAK	SPAWNING END	DIE-OFF START	DIE-OFF PEAK	DIE-OFF END
NORTH COAST												
Mathers Ck.	1978	NP	Float, Foot Surveys	before Sept. 8	-	-	before Sept. 8	last week Sept.	Oct. 22	Sept. 13	-	-
		SF		Aug. 29	-	-	Sept. 14	Sept. 25	Oct. 30	-	-	-
	1979	NP	Float, Foot Surveys	-	-	-	mid-Sept.	-	mid-Oct.	-	-	-
		SF*		-	-	-	-	-	-	-	-	-
		SF (Avg.)		-	-	-	early Oct.	mid-Oct.	late Oct.	-	-	-
Kitlope R.	1981	NP	Aerial, Boat, Foot Surveys	early Aug.	-	-	mid-Aug.	early Sept.	late Sept.	-	-	-
		SF		mid-Aug.	-	-	late Aug.	early Sept.	mid-Sept.	-	-	-
		SF (Avg.)		July	-	-	Aug.	early Sept.	late Sept.	-	-	-
Kwatna R.	1983	NP	Foot, Float, Boat, Helicopter	late July	-	-	mid Aug.	mid Sept.	early Oct.	late Aug.	late Sept.	mid Oct.
		SF			-	-				-	-	-
		SF (Avg.)		Aug.	-	-	Aug.	early Sept.	Oct.	-	-	-
Quatlena R.	1983	NP	Foot, Helicopter	early Aug.	-	-	early Sept.	mid Sept.	mid Oct.	early Sept.	late Sept.	mid Oct.
		SF			-	-				-	-	-
		SF (Avg.)		Aug.	-	-	Aug.	Aug.	Sept.	-	-	-
Nootum R.	1983	NF	Foot, Boat, Helicopter	early Aug.	-	-	late Aug.	mid Sept.	late Sept.	mid Sept.	late Sept.	early Oct.
		SF			-	-				-	-	-
		SF (Avg.)		Aug.	-	-	Sept.	Sept.	Oct.	-	-	-
SOUTH COAST												
Kakweiken R.	1981	NP	Fishway Survey	July 15	Aug. 13	after Sept 11	-	-	-	-	-	-
		SF		July	-	-	Aug.	Sept.	Oct.	-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Sept.	Oct.	-	-	-
Glendale/ Tom Browne Cks.	1981	NP	Aerial, Foot Surveys	July 24	-	-	Sept. 7	Sept. 26	Oct. 24	-	-	-
		SF			-	-				-	-	-
	1983	NP	Aerial, Foot Surveys	July 20-25	Sept. 20	Oct. 10-15	Aug. 20-25	Sept30-Oct5	Nov. 5	Aug. 20	Oct. 15-25	Nov. 15
		SF			-	-				-	-	-
		SF (Avg)			-	-				-	-	-

* no information

COMPARISON OF PINK TIMING DATA OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	SOURCE	METHODS	IMMIGRATION START	IMMIGRATION PEAK	IMMIGRATION END	SPAWNING START	SPAWNING PEAK	SPAWNING END	DIE-OFF START	DIE-OFF PEAK	DIE-OFF END
Mussel Ck.	1981	NP	Aerial, Foot Surveys	Aug. 29	-	-	Sept. 15	Sept. 15	Oct. 15	-	-	-
		SF	Included in Klinaklini River									
	1983	NP	Fence, Foot, Aerial Surveys	Aug. 19	Aug. 25	-	Aug. 25	Sept. 15	-	Sept. 7	-	Sept. 29
		SF	Included in Klinaklini River									
		SF (Avg)	Included in Klinaklini River									
Annuhati R.	1981	NP	Aerial, Foot Surveys	July 23	-	-	Aug. 30	Sept. 1-7	Oct. 1	-	-	-
		SF			-	-				-	-	-
	1983	NP	Aerial, Foot Surveys	Aug. 1	Aug. 25	Aug. 31	Aug. 15	Sept. 2-5	Oct. 1	Aug. 29	Sept. 22	Oct. 15
		SF			-	-				-	-	-
		SF (Avg)		July	-	-	Aug.	Sept.	Oct.	-	-	-
Sucwoa R.	1978	NP	Foot Surveys	-	-	-	early Sept.	-	-	-	-	-
		SF			-	-				-	-	-
		SF (Avg)		Aug.	-	-	Sept.	Sept.	Oct.	-	-	-
FRASER R., N.B.C. and YUKON												
Adams R. (lower)	1981	NP	Foot Surveys	Oct. 2	-	-	-	-	-	-	-	-
		SF		Sept. 25	-	-	Oct. 1	Oct. 1	Oct. 31	-	-	-
		SF (Avg)		late Sept.	-	-	early Oct.	early Oct.	mid-Oct.	-	-	-
South Thompson R.	1981	NP	Foot Surveys	-	-	-	Oct. 1	-	-	Oct. 1	-	mid-Oct.
		SF*		-	-	-		-	-	-	-	-
		SF (Avg)		Sept.	-	-	Oct.	early Oct.	Oct.	-	-	-
North Thompson R.	1981	NP	Foot Surveys	-	-	-	before Sept. 26	-	-	-	-	Oct. 5
		SF			-	-				-	-	-
		SF (Avg)	no reports									

* no information - escapement given but no timing data.

- As with spawning escapement estimates, timing estimates provided by fishery officers are often based on limited observations, ie field excursions are generally planned for the dates when it is believed that, (1) immigration will be starting, (2) spawning will be starting (3) spawning activity will be peaking, and (4) spawning and die-off will be complete, or nearly so.

- Often the NP vs. SF information is in agreement but NP start and end run timing dates are, respectively, prior to and after those indicated by SF information, in many cases. This may be a reflection of the grater effort made by personnel gathering NP data. Unfortuately, the greatest drawback to the NP data is that project initiation and termination dates usually fall well within the boundaries of run timing, resulting in little concrete data being presented on the initial immigration or final die-off periods.

- NP timing data is usually more specific than that given by Stream file (Spawning Ground) Reports.

- SF (avg) indicates average run timing for previous ten years.

APPENDIX C-2

SPAWNER DISTRIBUTIONS

This section contains subjective notes on the habitat type, river location and degree of concentration for actual and potential spawning and holding areas. The "methods" column refers to methods of observing fish and habitat, rather than methods for determining fish distribution (eg. tag and recovery methods). All kilometer values denote distances above the stream mouth unless otherwise indicated.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST - Cont'd	
Kowesas R.	1981	Rosberg et al, 1982	Helicopter & Fixed-Wing Overflights, Boat & Foot Surveys	Holding was documented some 27 km from the mouth. The high turbidity and presence of extensive logjams in this stream are believed to provide suitable conditions for holding salmon. Spawning, while not observed during the course of of the survey, was assessed as having limited potential.
Tsaytis R.	1981	Rosberg et al, 1982	Helicopter & Fixed-Wing Overflights, Boat & Foot Surveys	Holding fish were sighted only at approx. kilometer 5 and no spawning activity was observed. Shifting bed materials likely limit spawning potential, which exists only in reaches 2 and 5.
Kwatna	1983	Rice, 1984	Foot, Float, Boat Helicopter Surveys	All six fish observed were located about 22 km upstream from the mouth. Unused, but potential areas exist at about km 16, between km 28.2 and 30.0 and in several tributary streams. Holding areas were not documented.
			SOUTH COAST	
Kakweiken R.	1981	Slaney and Milko, 1982	Float and Foot Surveys	Holding fish were observed in deep pools at approx. 3 km from the mouth. Information on spawning distribution is lacking.
Mussel Ck.	1981	Fielden and Slaney, 1982	Float, Foot and Aerial Surveys	Holding fish primarily utilized pool habitat in the lower 4 km of this stream and between kilometers 5 and 7. Spawning was most concentrated between kilometers 6 and 7, while activity was observed to a lesser degree between kilometers 3 and 6.
	1983	Whelen and Morgan, 1984	Foot and Aerial Surveys	Fish held in shallow pools throughout the stream and major holding pools were located at approx. 0.5, 1.5 and 5.5 km from the mouth. Ninety-five percent of the population spawned between km 1.5 and 6.0, while the greatest densities were recorded between kms 1.5 and 2.5.
Klinaklini R.	1983	Whelen and Morgan, 1984	Foot and Aerial Surveys	Holding fish were not reported in the mainstem. Spawning activity also appeared to be absent from the mainstem but was observed in the lower 1.5 km of Link Channel and the lower 1.0 km of Dice Creek, both located on the west side of the river above the Mussel Creek confluence.
Ahnuhati R.	1981	Fielden and Slaney, 1982	Float, Foot and Aerial Surveys	Scattered holding was observed throughout the lower 3 km of stream. Spawning activity was low and limited to the area between kilometers 7 and 10.5. Holding fish were also seen in this area.
	1983	Whelen and Morgan, 1984	Foot and Aerial Surveys	Holding fish were reported in pools between 7 and 10.5 km from the mouth. In addition, 45% of the population spawned in this section. Lesser concentrations of spawners were also seen between approx. 2 and 6 km.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST	
Morice R.	1978	Smith and Berezay, 1983	Helicopter Overflights	Scattered to heavy spawning activity occurred throughout the mainstem between the Morice/Bulkley confluence and Morice Lake. Spawner density increased with distance upstream from the river mouth. The greatest proportion of spawners (48% of the population) was observed in a 3.2 kilometer section immediately below the Morice Lake outlet.
	1979	Smith and Berezay, 1983	Boat Survey	Spawner distribution was similar to that observed in 1978 and an even greater proportion of the spawning population, approx. 80%, utilized the 3.2 km long stretch of river below the Morice Lake outlet. The 3 holding areas were island perimeters in reach 8, 8.2 km downstream from Morice Lake and near the Gosnell Creek mouth.
	1980	Smith and Berezay, 1983	Helicopter Overflights	Between 13 and 22% of the total escapement spawned between Lamprey and Owen Creeks; no other information on spawning was given and holding areas were not documented.
Kitlope R.	1981	Rosberg et al, 1982	Helicopter & Fixed-Wing Overflight & Boat & Foot Surveys	Spawners were distributed roughly between 12 and 45 km upstream from the mouth, while the greatest activity was reported at the outlet of Kitlope Lake (at the junction of the Kitlope River). Both holding activity and suitability were rated as low.
Gamsby R.	1981	Rosberg et al, 1982	Helicopter & Fixed-Wing Overflight & Boat & Foot Surveys	Holding areas are limited and only 1 location, approx. 3.5 Km upstream from the mouth, was utilized. Spawning activity was low or scattered to ~ 8 km, and nil upstream of this point. Spawning potential ranges from scattered to moderate between roughly 20 and 30 km above the mouth.
Tezwa R.	1981	Rosberg et al, 1982	Helicopter and Fixed-Wing Overflights, Boat & Foot Surveys	Holding locations were not noted and spawning areas located between approx. 13 and 15 km from the mouth were utilized only sparsely.
Kalitan Ck.	1981	Rosberg et al, 1982	Helicopter & Fixed-Wing Overflights, Boat & Foot Surveys	Holding areas were described as abundant but area-specific descriptions were not discussed for individual species. Overall spawning potential was assessed as moderate between the mouth and approx. 10 km but actual utilization was low and restricted to an area approx. 8 km upstream from the mouth. Some limited spawning potential exists as far upstream as kilometer 14.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			SOUTH COAST - Cont'd	
Sucwoa R.	1978	Glova and McCart, 1979	Foot Surveys	Localized spawning was observed in relatively fast flows and coarse substrates between 1.0 and 2.5 km from the mouth.
Canton Ck.	1978	Glova and McCart, 1979	NA*	Chinook spawning activity, while not noted, was probable between kms 3.5 and 3.8, immediately below the canyon.
Conuma R.	1978	Glova and McCart, 1979	NA	It was believed that spawning occurred prior to survey initiation.
Nitinat R.	1979	McCart et al, 1980	Boat Surveys	Spawning was noted throughout the study area, from the river outlet into Nitinat Lake upstream to just past Parker Creek. The largest proportion of spawners were located upstream of the confluence with the Little Nitinat River, between kms 4.8 and 5.0.
Little Qualicum R.	1978	Lister, 1979	Foot Surveys	All spawning was observed in the upper portion of the survey area, between 6.5 and 9.5 kilometers from the mouth.
			FRASER R., N.B.C., and YUKON	
Holmes R.	1981	Rosberg and Aitken, 1982	Boat, Float, Foot and Helicopter Surveys	Suitable holding areas were found in an area below km 21 and near the mouth as well as under logjams scattered throughout the lower reaches; site-specific details on the distribution of holding salmon were not given. The bulk of spawning activity occurred between kms. 4 and 5.5, although this was rated as low and underutilized.
Morkill R.	1981	Rosberg and Aitken, 1982	Helicopter Survey	It is believed that adults first hold in the Upper Fraser mainstem and subsequently enter this stream just prior to spawning, due to the general lack of suitable holding areas in the Morkill. Spawning was restricted to an area located at km 18.0, and immediately above the Hellroaring Creek outlet. The highest potential for spawning (rated as moderate) exists between kms 17 and 20, while scattered spawning potential occurs between kms 11.5 and 14.
Torpy R.	1981	Rosberg and Aitken, 1982	Foot and Helicopter Surveys	One large pool, located 34 km above the mouth, was utilized for holding, otherwise, stream features generally do not lend themselves well to such activity. Spawning was most concentrated between kms 54 and 72; actual and potential use of this area was rated as low-medium and medium, respectively. Observed and potential utilization for areas further downstream was rated from nil to scattered, while the area above km 86 was rated as having medium potential although passage is currently blocked at approx. 80 km. Presently, spawning occurs to km 75.

* - Not applicable.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
FRASER R., N.B.C. and YUKON - Cont'd				
West Torpy R.	1981	Rosberg and Aitken, 1982	Foot and Helicopter Surveys	No suitable areas for holding exist in this stream. Spawner distribution was scattered from the Torpy River confluence to km. 9.5 and nil above this point. Overall spawning potential is low.
Walker Ck.	1981	Rosberg and Aitken, 1982	Foot and Helicopter Surveys	Suitable areas for holding were observed but holding fish were no longer present by survey commencement. Both observed and potential spawning was highest in the lower 6.5 kilometers of stream. The remaining activity was confined to an area between kms. 7.0 and 8.5.
Slim Ck.	1980	Murray et al, 1981	Boat, Helicopter and Foot Surveys	Spawning concentrations were greatest immediately below Tumuch Lake, between kms 37 and 38, and below Slim Lake, between kms 31 and 32.5. Over 60% of the total population spawned in this latter section. Lesser concentrations of spawning fish were observed throughout the remainder of the area surveyed, between km 43 and the mouth.
	1981	Rosberg and Aitken, 1982	Canoe, Foot, Helicopter Surveys	Major holding areas are located between kms 14 and 15 as well as 100 m downstream from the mouth of Everett Creek. Both potential and actual spawner utilization were greatest between kms 32 and 33, and use was likely at or near capacity. Lower concentrations of spawners were scattered below this point to km 16 and above to km. 47.
Bowron R.	1980	Murray et al, 1981	Boat, Helicopter and Foot Surveys	Spawning was observed in all surveyed sections of the river between approx. 110 and 143 km upstream of the mouth. Primary concentrations occurred between kms. 118.5 and 123.5 and kms. 133 and 137.
Willow R. and Wansa Ck.	1980	Murray et al, 1981	Boat, Helicopter and Foot Surveys	About 80% of the population spawned between kms. 20 and 30.5 in the mainstem, while 73% of the Wansa Ck. population spawned between kms. 11 and 12.5 of that stream. Scattered spawning was also present over a 6.5 km area immediately below Wansa Lake.
Stuart R.	1980	Hickey and Lister, 1981	Helicopter and Boat Surveys	The majority of spawners (73.2%) were concentrated along a 1 km section of the mainstem immediately downstream from Dog Creek. Only 3% of the population spawned between the Stuart Lake outlet and the upper end of the canyon. Only scattered spawning was observed throughout the remainder of the river.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
				FRASER R., N.B.C. and YUKON - Cont'd
Nechako R.	1979	Olmsted et al, 1980	Float, Boat, Helicopter Surveys	Holding pools were located at 2.7, 14.6, 58.8, 83.7, 85.3 and 91.7 kms upstream from Vanderhoof. Although spawning occurred through much of the area surveyed, between Vanderhoof and Cheslatta Falls, some 50% of the total escapement spawned over a 7.5 km long section, beginning 5.8 km downstream of Cheslatta Falls. Superimposition of redds was noted in this section.
Blackwater R.	1980	Olmsted et al, 1981	Helicopter Survey	Spawning occurred primarily in shallow riffles between the confluences with the Nazko and Euchiniko Rivers. Below the Euchiniko River spawning activity was very limited.
Nazko R.	1980	Olmsted et al, 1981	Helicopter Survey	Primary concentrations of spawning chinook were found in a series of riffles 5km below the Chisbako River confluence and at a point 1 km. upstream of the Nazko River bridge. These two areas were well-utilized by spawners, whereas the remainder of the river contained only very limited activity.
Cottonwood R.	1980	Olmsted et al, 1981	Helicopter Survey	The majority of the spawning effort occurred between the confluences of Victoria and Soverign Creeks. Much of the remaining effort was concentrated about 3 km downstream from the Sovereign Creek Outlet.
Horsefly R.	1979	Olmsted et al, 1980	Foot, Float, Helicopter Surveys	Several holding areas were identified between the McKinley Creek confluence and a point approx. 1 km downstream from Tisdall Creek. Intensive spawning activity (87%) was documented from approx. 1.5 km below McKinley Creek to approx. 0.75 km above. The remaining 13% of the population spawned below this section over a 2 km area.
	1980	Olmsted et al, 1981	Foot, Float, Helicopter Surveys	Holding pools were scattered between the McKinley Creek confluence and a point approx. 0.5 km downstream from Tisdall Creek. The major spawning area occurred just below the McKinley Creek confluence over a 1.5 km stretch of river. Spawning activity over the rest of the study area, from below Horsefly River Falls to just below Tisdall Creek, was fairly even.
McKinley Ck.	1980	Olmsted et al, 1981	Foot and Helicopter Surveys	An estimated 97% of the population spawned from the Horsefly River confluence to a point approx. 2.5 km upstream.
Quesnel R.	1979	Olmsted et al, 1980	Foot, Float, Boat, Helicopter Surveys	Pools suitable for holding occurred, approximately, at 2.5, 3.0, 4.5 and 8.0 km downstream from the outlet of Quesnel Lake. Spawning was concentrated near the lake outlet and between 3 and 4 km downstream.
	1980	Olmsted et al, 1981	Foot, Float, Helicopter Surveys	Holding pools were identified in several locations between the Quesnel Lake outlet and a point 5.8 km downstream, the most suitable of these were between 1.3 and 3.7 km downstream from Quesnel Lake. Spawning effort was highest between the confluence with the Cariboo River and Lawless Creek and over a 1.2 km area beginning 2.0 km downstream of Quesnel Lake. Although the section between Lawless Creek and the Cariboo River contained over 23% of the estimated escapement, spawner density was very low, due to optimal gravel conditions throughout. Other areas, while containing low numbers of spawners, had greater utilization of suitable substrates as these were generally lacking.

CHINOOK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
				FRASER R., N.B.C. and YUKON - Cont'd
Eagle R.	1981	Whelen and Olmsted, 1982	Foot, Float, Boat, Helicopter Surveys	Three major holding pools occurred 4.5 to 5.5 km upstream from the Perry River confluence, while other holding locations were situated at 0.7, 1.1, 7.3 and 8.1 kms upstream from the Perry River confluence. An estimated 67% of the population spawned from the Griffin Lake outlet to Tumbler Creek. Most of the remaining activity was confined to the section between Kay Falls and the Perry River.
Salmon R.	1981	Whelen and Olmsted, 1982	Foot, Float, Helicopter Surveys	Holding fish were most concentrated in pools and under logjams from Glenemma to about 5 kms above Falkland. Spawning activity was greatest over a 2.5 km section above Glenemma and a 4 km section above Falkland. Spawning was observed as far downriver as 2.5 km below Silver Creek. Redd superimposition was evident in areas with the greatest spawner densities.
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Foot, Float, Boat, Helicopter Surveys	An area of Shuswap Lake near the river mouth and between km 1.1 of the mainstem and Adams Lake were utilized by holding fish. Spawning effort was highest between km 2 and Adams Lake, where approx. 83% of the population reproduced. The balance of the fish spawned below this area. No use was made of the 3 tributary streams.
South Thompson R.	1981	Whelen and Olmsted, 1982	Foot, Float, Boat, Helicopter Surveys	Deep pools in the mainstem between Pritchard and a point just downstream of the Little Shuswap Lake outlet were preferred holding areas, while holding fish were also observed in similar habitat in the Little River. Spawning activity was concentrated between Little Shuswap Lake outlet and a point 2.5 km downstream; some 58% of the population reproduced in this section. The areas adjacent to Campbell and Monte Creeks were also well-utilized and contained approx. 4% and approx. 9% of the total escapement, respectively. Spawning was scattered and occasionally intense in localized areas of the remainder of the area surveyed.
Finn Ck.	1981	Scott et al, 1982	Foot Surveys	Pools in the lower 1.8 km of this stream were utilized by spawning chinook, while spawning was conducted over the lower 3.9 km, the area between kms 1.6 and 2.3 receiving the most intensive use.
Raft R.	1981	Scott et al, 1982	Foot and Float Surveys	Holding fish were observed in pools along the lower 3 km of the river. Eighty-seven percent of the river escapement spawned between kms 1.1 and 3, while the remainder spawned upstream to km 3.4 and downstream to the mouth. In the areas of highest spawning intensity, concurrent spawning by sockeye may have resulted in some displacement and redd superimposition.
North Thompson R.	1981	Scott et al, 1982	Foot and Helicopter Surveys	Holding, although not observed, was believed to have occurred in slow runs between Little Fort and Clearwater. Spawner densities were highest between 6.2 and 17.9 kilometers upstream of Little Fort. Roughly 88% of the total population spawned in this section. Moderate activity was also noted over a 1 km area just downriver from Little Fort.

COHO SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST	
Mathers Ck. (incl. tribs)	1978	Glova et al, 1979	Foot and Float Surveys	Large groups of holding fish were observed in pools from 0.4 to 2.0 kms and 4.5 to 8.4 kms from the mouth. Spawning coho were sighted in an area approx. 8.4 km from the mouth, in Fukawa Creek between 0.9 and 2.0 kms upstream from its confluence with Mathers Creek, and in the major tributary at the south end of Mathers Lake.
	1979	Grant and McCart, 1980	Foot, Float and Helicopter Surveys	Holding fish were concentrated in the area immediately below the lake outlet. Limited spawning was also observed near the lake outlet and in the main tributary at the south end of the lake.
Kitlope R.	1981	Rosberg et al, 1982	Foot, Boat and Aerial Surveys	Holding activity was not documented and only limited spawning information was gathered. Site specific details were not given.
Gamsby R.	1981	Rosberg et al, 1982	Foot, Boat and Aerial Surveys	The heaviest spawning activity was found below km 8.4 and no spawning was evident above km 12.5.
Tezwa R.	1981	Rosberg et al, 1982	Foot, Boat and Aerial Surveys	Only limited information on spawner distribution was collected. Areas located between approx. 11.6-17.4 km and 29.4-39.3 km from the mouth were identified as having medium or better spawning potential. However, rapid fluctuations in water levels may impede egg survival.
Kawesas R.	1981	Rosberg et al, 1982	Foot, Boat and Aerial Surveys	Coho heavily utilized the area between km 15.5 and 25.2 for spawning, particularly where a spring entered the stream at km 25.
Tsaytis R.	1981	Rosberg et al, 1982	Foot, Boat and Aerial Surveys	All spawning activity occurred between km 6.7 and 15.8. Low to medium potential exists in various locations between the mouth and 6.7 kms as well as between km 16.4 and 20.1.
Kwatna R.	1983	Rice, 1984	Foot, Float, Boat, Helicopter Surveys	Holding was observed between approx. km 7 and km 22.0. Although no spawning was actually observed, potential sites exist over much of the river to km 32.3.
Oak-Beck Ck.	1983	Rice, 1984	Foot, Helicopter Surveys	Coho were observed holding in pools to approx. km 8. Spawning, while not observed, was likely conducted to approx. km 8.5.
Nootum R.	1983	Rice, 1984	Foot, Boat, Helicopter Surveys	Holding fish were present at approx. km 8 but no spawning activity was observed.

COHO SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
SOUTH COAST - Cont'd				
Tlupana R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning is distributed throughout this stream between 0.5 and 5.7 kms from the mouth, and it is probable that spawning takes place over much of the accessible length.
Nitinat R.	1979	McCart et al, 1980	Boat Surveys	The largest concentration of holding fish were observed from 2.5-2.9 km above the Little Nitinat River, while much of the spawning was conducted in tributary streams.
Little Qualicum R.	1978	Lister, 1979	Foot Surveys	A few large pools, located at the mouth of Whiskey Creek, below the power line and at the mouth of Kinkade Creek, serve as holding areas for the majority of fish. Tributaries appear to receive the greatest use by spawning coho.
FRASER R., N.B.C. and YUKON				
Eagle R. (incl. South Pass Ck.)	1982	Whelen et al, 1983	Foot Surveys	Numerous pools in the area between the Crazy Creek confluence and Griffin Lake and between Three Valley and Victor Lakes were utilized by holding coho. Spawning was observed from the Perry River confluence to Summit Lake and in South Pass Creek. Maximum spawner density was reached over a 1 km area immediately below Summit Lake.
Salmon R. (incl. Bolean Ck.)	1982	Whelen et al, 1983	Foot Surveys	Holding fish were enumerated in numerous small pools from 2.1 km above to 18.3 km below Falkland. Spawning fish were concentrated along an approx. 4 km stretch of river, roughly centered at Falkland. Extensive redd superimposition was recorded near the upper limit of this section. Spawning was also observed in Bolean Creek to 7.2 km.
Adams R. (lower) (incl. tribs.)	1981	Whelen and Olmsted, 1982	Foot, Float, Boat and Helicopter Surveys	Coho were observed holding near the mouth of Hiuihill Creek. No other information was presented.
	1982	Whelen et al, 1983	Foot Surveys	Holding areas were widely distributed and included small pools in all 3 tributaries. Spawning density was highest in Nikwikwaia Creek but overall numbers were low and the area of suitable habitat was small.
Adams R. (upper) (incl. Momich R. and Cayenne Ck.)	1982	Whelen et al, 1983	Foot Surveys	Holding pools were identified at km 42 and 63 of the mainstem and in Cayenne Creek near its confluence with the Momich River. Seventy-eight percent of the total escapement spawned in Cayenne Creek. Only low numbers of spawners were observed in the mainstem. These utilized the river from km 48 to the upper limit of the survey area (km 84).

COHO SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			SOUTH COAST	
Kakweiken R.	1981	Slaney and Milko, 1982	Foot, Float and Helicopter Surveys	Most holding fish were observed above the fishway, in deep pools or riffles, as far as 8 km above Kakweiken Lake. Spawning was also observed above Kakweiken Lake.
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	Large numbers of coho were observed (holding?) off the mouth of a tributary on the north shore of Glendale Lake.
	1983	Whelen and Morgan, 1984	Foot Surveys	The high pink escapement may have forced fish upstream to hold in Glendale Lake as none were observed in the stream.
Mussel Ck.	1981	Fielden and Slaney, 1982	Foot, Float and Helicopter Surveys	Four pools below Mussel Lake contained the greatest proportion of holding coho, while small groups were observed in pools located at approximately 5 and 12 km. The majority of spawning salmon were observed in side channels located at approx. 5 km. at 0.8-1.3 km and 1.8-2.5 km upstream of Mussel Lake. It is believed that Mussel Lake also served as a holding area, as water levels in the upper watershed were low during immigration.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Ninety-five percent of the population spawned between km 11.7 and 12.5, while 4% spawned from km 1.7 to 2.2. Distribution of spawners varied considerably from that observed in 1981 by Fielden and Slaney.
Klinaklini R.	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Coho were observed in Icy Creek (Lower Link Channel) throughout Link Channel and in lower Dice Creek. The majority of holding fish were observed in a single pool in the upper area of Link Channel.
Ahnuhati R.	1981	Fielden and Slaney, 1982	Foot, Float and Helicopter Surveys	Holding salmon were observed between kms. 1.7 and 3.5, 5.0 and 6.0, 7.7 and 8.4, 9.7 and 10.2. At no time were coho sighted above km. 10.2, although surveys were terminated prior to the initiation of spawning.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Holding fish were concentrated between km 0.8 and 4.7. Small groups of holding fish were sighted in various upstream locations to km 14.4. Spawning distribution was not determined.
Franklin R.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	Only 1 coho was observed digging a redd in a small tributary on the west side of the river.
Kwalate Ck.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	The majority of holding fish were observed near the creek mouth, below the cascades. Scattered holding areas were reported in several locations to km 10.

COHO SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
FRASER R., N.B.C. and YUKON- Cont'd				
Albreda R.	1982	Hutton et al, 1983	Foot Surveys	Holding fish were not observed due to the late start of the project. However, numerous small pools in the upper river and a few larger pools in the lower river provide a suitable environment for holding. Spawning was widely distributed and scattered above the Clemina Creek confluence. The major spawning area appeared to lie within a 1 km stretch of river some 5 km above the Clemina Creek confluence.
Blue R.	1982	Hutton et al, 1983	Foot Surveys	Several relatively large pools between approx. 1.5 and 2.0 km from the mouth contained holding coho, the most significant of these, in terms of utilization, was located approx. 100 m upstream of the CNR railway bridge. Only scattered spawning was observed between km 1.5 and 2.0.
Lion Ck.	1982	Hutton et al, 1983	Foot Surveys	The majority of holding fish were observed in a single pool, located approx. 0.5 km from the mouth. Spawning activity was observed throughout the lower 2.7 km of stream and was most intense over the lower 0.8 km.
Wire Cache Ck.	1982	Hutton et al, 1983	Foot Surveys	No holding fish were observed and very little suitable area exists for this purpose. Spawning occurred throughout the 300 m accessible area.
Lemieux Ck.	1982	Hutton et al, 1983	Foot Surveys	Holding fish were widely distributed amongst the many small pools present over much of the lower 8 km of stream. The largest number of holding fish were observed in a large pool near the Demers Creek confluence. Scattered spawning occurred between the creek mouth and km 10 and was most concentrated between km 6 and 7.
Barriere R.	1982	Hutton et al, 1983	Foot Surveys	Spawning activity was concentrated near the outlet of North Barriere Lake, where approx. 86% of the population spawned in a 0.5 km stretch of river.
Louis Ck.	1982	Hutton et al, 1983	Foot Surveys	The heaviest spawning occurred between km 42.2 and 46.7.
Coldwater R.	1982	Whelen et al, 1983	Foot Surveys	Holding pools were located at km 28.6, 33.6, 35.7, 42.8, 46.4 and 53.6. Spawning occurred between km 25.7 and 54.3 and was heaviest between km 33.6 and 35.5.

CHUM SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST	
Mathers Ck. (incl. tribs.)	1978	Glova et al, 1979	Foot and Float Surveys	Spawning was most concentrated in the upper watershed, particularly between km 5.0 and 7.5. In the lower portion of stream, spawning was scattered and most of the activity occurred between km 0.7 and 1.4.
	1979	Grant and McCart, 1980	Foot, Float and Helicopter Surveys	Spawning was concentrated at 2 sites, both within 1 km of the mouth. Distribution of spawning was significantly altered from 1978, due to modification of the stream bed by flooding.
Kitlope R.	1981	Rosberg et al, 1982	Helicopter, Fixed Wing, Boat and Foot Surveys	The majority of spawning fish were observed between 8.8 and 26.6 kms upstream of the mouth; a small number were sighted below this. No spawning or holding was noted above 26.6 km.
Gamsby R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat and Foot Surveys	Spawning was observed only in 2 side channels, located at the mouth and at 3 km upstream. The mainstem exhibited little suitability for spawning.
Kowesas R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat and Foot Surveys	All spawning was conducted at roughly km 9.6 and spawning potential was described as low at best.
Tsaytis R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat and Foot Surveys	Holding fish were observed in groundwater-fed side channels at km 6.0, 9.0, 9.6 and 12.6. It is believed they also spawned in these side channels. Limited spawning potential exists as far upstream as km 15.8.
Kemano R. (incl. tribs.)	1979	Murray and Hamilton, 1981	Ground and Aerial Surveys	The majority of fish spawned between km 5.2 and 8.4, and other than a section between km 8.4 and 10.5, spawners were observed throughout the river to km 12.5.
Kwatna R.	1983	Rice, 1984	Foot, Float, Boat, Helicopter Surveys	Spawning was observed to km 15.0, the most intense activity occurring in the upper portion of this area. Areas further downstream exhibited good potential and were considered as underutilized. The majority of chums spawned in tributary streams.
Gus Ck.	1983	Rice, 1984	Foot, Helicopter	Spawning fish were observed to approx. km 0.6.
Oak-Beck Ck.	1983	Rice, 1984	Foot, Helicopter	Spawning was conducted over the lower 2 km of this stream. Sixty-three percent of the chum escapement to the Kwatna River watershed was observed in this stream.
Slousiska Ck.	1983	Rice, 1984	Foot, Helicopter	Although suitable spawning gravels were present to 560 m upstream from the mouth, chums were not observed spawning past approx. the 200 m point.
Glaciers Ck.	1983	Rice, 1984	Foot, Helicopter	Only low utilization occurred and was confined to the lower 200 m, approximately.

CHUM SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST - Cont'd	
Quatlena R.	1983	Rice, 1984	Foot, Helicopter	All chum spawning was confined to the lower-most portion of the river, in close proximity to the estuary. Most activity (62% of the population) spawned in a narrow side channel immediately above the mouth.
Nootum R.	1983	Rice, 1984	Foot, Boat, Helicopter	Spawning was observed to approx. 3.5 km from the mouth, with the highest counts occurring in the upstream portion of this area. Habitats were classed as substantially underutilized.
			SOUTH COAST	
Kakweiken R.	1981	Slaney and Milko, 1982	Foot and Float Surveys	Chum were observed holding at km 5.6, 9.0 and in lower Elbow Creek. Spawning was noted in several locations below Lower Kakweiken Lake, the most notable of these being a 1.6 km section extending upstream from the mouth.
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	Foot and Aerial Surveys	Spawning effort was concentrated between km 1.2 and 2.2 in Tom Browne Creek. Limited spawning also occurred from km 1.7 to 2.4 and from km 7.5 to 8.0 in Glendale Creek.
	1983	Whelen and Morgan, 1984	Foot Surveys	Tom Browne Creek contained 97.2% of the spawning population while scattered spawning was reported to km 4.8 of Glendale Creek. Under 3% of the total population spawned in Glendale Creek.
Mussel Ck.	1981	Fielden and Slaney, 1982	Foot, Float and Aerial Surveys	Holding appeared to be of short duration and confined to the lower 1.6 km of stream. Spawning was observed between km 1.6 and 2.0. Spawning intensity was rated as heavy in this section.
	1983	Whelen and Morgan, 1984	Foot and Aerial Surveys	Holding and spawning distributions were similar to those encountered in 1981.
Kilnakilni R.	1983	Whelen and Morgan, 1984	Foot and Aerial Surveys	Chum spawning occurred in upper and lower Link Channel. In addition, observations of chum were made in Icy and Dice Creeks.
Ahnuhati R.	1981	Fielden and Slaney, 1982	Foot, Float and Aerial Surveys	Holding was observed in the lower 0.9 km, while spawning was noted in several locations between km 2.2 and 8.8.
	1983	Whelen and Morgan, 1984	Foot, Float and Aerial Surveys	Spawning intensity was greatest between km 3.4 and 5.1, while low to moderate activity was reported for other areas between km 0.5 and 10.4.
Kwalate Ck.	1981	Fielden and Slaney, 1982	Foot and Aerial Surveys	All observed spawning and holding was restricted to a 400 m reach below the cascades near the creek mouth.

CHUM SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			SOUTH COAST - Cont'd	
Sucwoa R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning was widespread and most concentrated in those areas which exhibited an intermediate velocity and water depth and moderate-sized gravels. Four areas in the mainstem, located at kms 0.3 to 0.4, 0.8 to 1.0, 1.1 to 1.2 and 1.3 received the highest use. The lower 0.2 km section of tributary "A", which flows into the mainstem near the estuary, was also well-utilized. Above km 1.3 only scattered spawning was observed. The upper limit of spawning activity was at km 2.1. High velocities and coarse substate material impeded spawning above this point.
Canton Ck.	1978	Glova and McCart, 1979	Foot Surveys	Spawning was primarily conducted at km 0.5 to 0.7, 0.8-1.0 and 1.2. Generally scattered spawning was reported upstream to km 3.2.
Conuma R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning occurs from the estuary to within 1 km of the base of the canyon (km 5.8) but is concentrated between the mouth and the hatchery site and between km 2.9 and 3.3.
Tlupana R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning activity was observed from the short canyon near the mouth to km 5.3, over variable habitat. The most concentrated spawning areas were found at kms 0.8 to 0.9 and 1.4 to 2.1. No spawning was observed in the Nesook River.
Deserted Ck.	1978	Glova and McCart, 1979	Foot Surveys	Utilization of the accessible portion of this stream was complete, excepting 2 deep bedrock-controlled pools. Superimposition of redds was a frequent occurrence and, in response to crowding, spawning in the intertidal zone was intense but fluctuated with the tides, the most activity taking place during low tide.
Nitinat R.	1979	McCart et al, 1980	Boat Surveys	Spawning was observed throughout the accessible length of the mainstem, ie: to km 8.6, and was concentrated below the confluence of the Little Nitinat R. Approximately 86% of the population spawned in the lower 2.6 km of the mainstem.
Little Qualicum R.	1978	Lister, 1979	Foot Surveys	Spawning occurred between the mouth and km 12.3 and was most intense between the mouth and km 3.0, where 35.9% of the population spawned.

SOCKEYE SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST	
Kitlope Lk.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing and Boat Surveys	Large numbers of fish were observed near the lake outlet. Spawning occurred in alluvial deposits of 2 glacial streams on the southeast margin of the lake. These locations are well-documented in spawning ground reports since 1947.
Tezwa R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat, and Foot Surveys	Holding areas are limited and observations of holding fish were restricted to one location at km 1.8. The major spawning areas were located between km 11.0 and 16.0. The area between km 27 and 37 appears to have good spawning potential.
Kalitan Ck.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat, and Foot Surveys	Although holding areas are abundant over the lower 9 km, the presence of suitable areas further downstream, in the Tezwa River and Kitlope Lake, results in very little holding in Kalitan Creek. Spawning activity is greatest along the lower 9.0 km of stream, particularly near the mouth. Scattered spawning was observed between km 9.0 and roughly 12.0.
Kowesas R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat and Foot Surveys	Only one observation of sockeye was made. Potential for spawning is generally nil or low.
Kemano R.	1979	Murray and Hamilton, 1981	Ground and Aerial Surveys	Sockeye were observed holding in the tailrace at Kemano and spawning in Horetzky Creek. As this system contains no lakes there is a possibility that these fish were strays from another system.
Kwatna R.	1983	Rice, 1984	Foot, Float, Boat, Helicopter	Spawning occurred throughout much of the mainstem from the mouth to km 12.6, with the majority of the activity being recorded adjacent to the Slousiska Creek confluence.
Oak-Beck Ck.	1983	Rice, 1984	Foot, Helicopter	One spawning pair only was observed. This observation was made below km 2 in the east fork.
Slousiska Ck.	1983	Rice, 1984	Foot, Helicopter	Scattered spawning occurred over the lower 200 m of stream.
McNally Ck.	1983	Rice, 1984	Foot, Helicopter	No spawning or holding fish were seen. A single observation of 2 sockeye was made, these were jumping a small falls located 500 m upstream from the south. This stream exhibits little potential for spawning.
			SOUTH COAST	
Kakweiken R.	1981	Slaney and Milko, 1982	Foot, Float and Helicopter Surveys	Holding sockeye were present in deep pools at km 2.3, near the falls. Spawning sockeye were observed between Kakweiken and Lower Kakweiken Lakes, with the highest concentration located between the outlet of Kakweiken Lake and the 1st set of cascades downstream.

SOCKEYE SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
SOUTH COAST - Cont'd				
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	A limited number of fish were observed in the lower portion of this stream but specific information on holding and spawning was not gathered.
	1983	Whelen and Morgan, 1984	Foot Surveys	Holding fish were sighted in pools at unspecified locations.
Mussel Ck.	1981	Fielden and Slaney, 1982	Foot, Float and Helicopter Surveys	Spawning was observed within the lower 1.5 km of stream and sightings were made at roughly km 5.0.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	The majority of both holding and spawning fish were observed between roughly 4.3 and 6.0 km above the mouth, while only scattered spawning occurred below km 4.3.
Kilnakilni R.	1983	Whelen and Morgan, 1984	Foot and Helicopter Overflights	Low numbers of spawning sockeye were observed in upper and lower Link Channel and 1 fish was observed in Dice Creek.
Ahnuhati R.	1981	Fielden and Slaney, 1982	Foot, Float and Aerial Surveys	Several observations were made of sockeye. All were below km 11.0.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Observations were confined to an area between kms 1.9 and 5.3, the majority of which were sighted below km 3.2.
Sucwoa R.	1978	Glova and McCart, 1979	Foot Surveys	A single observation of holding sockeye was made at the Gold River - Tahsis road crossing. It is believed that sockeye may spawn near Malaspina Lake in the mainstem or in tributaries. Several spent carcasses were recovered from tributary "A" and in another tributary at km 1.1.
Conuma R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning was observed at the mouth of a wide side channel approx. 0.3 km below the Hatchery site and also at the mouth of a small tributary located at km 3.9.
Little Qualicum R.	1978	Lister, 1979	Foot Surveys	All observations of sockeye were made between the pools off the mouth of Kinkade Creek to km 10.6 in the mainstem.
FRASER R., N.B.C. and YUKON				
Bowron R.	1980	Murray et al, 1981	Boat, Helicopter and Foot Surveys	Sightings were made between 2.4 and 19 kms upstream from the Indianpoint Creek confluence.
Nechako R.	1979	Olmsted et al, 1980	Float, Boat and Helicopter Surveys	Holding was observed in the pool at the base of Cheslatta Falls, at 5.3 km below Cheslatta Falls and at Vanderhoof. Holding in other areas was not described as to site but apparently holding areas were present between 13 and 24 kms downstream from Cheslatta Falls; spawning areas also fell into this section.

SOCKEYE SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
				FRASER R., N.B.C. and YUKON - Cont'd
Stuart R.	1980	Hickey and Lister, 1981	Boat and Helicopter	Several fish, presumed to be sockeye, were observed in the Dog Creek area.
Mitchell R.	1980	Olmsted et al, 1981	Helicopter Survey	Holding or spent fish were observed in the lower portion of the river.
Horsefly R.	1979	Olmsted et al, 1980	Helicopter Survey	Observations of sockeye were made in the upper Horsefly River.
	1980	Olmsted et al, 1981	Helicopter Survey	Holding and spawning took place between 45.5 and 49.7 kms upstream from the Quesnel River confluence.
McKinley Ck.	1980	Olmsted et al, 1981	Helicopter Survey	Holding and spent fish were found from the mouth to McKinley Lake, with the majority sighted from the McKinley Lake outlet to a point located 2.3 km downstream.
Quesnel R.	1980	Olmsted et al, 1981	Helicopter Survey	Holding and spent fish were observed approx. 1 km downstream from Likely.
Adams R.	1981	Whelen and Olmsted, 1982	Foot, Boat, Float and Helicopter Surveys	Holding areas occurred throughout much of the river course, while spawning, also observed throughout, was concentrated between km 1.1 and 2.0.
South Thompson R.	1981	Whelen and Olmsted, 1982	Foot, Boat, Float and Helicopter Surveys	Sockeye were observed spawning in the Little River. No other observations were documented.
Finn Ck.	1981	Scott et al, 1982	Foot Survey	Spawning was restricted to the creek mouth and marked the first occurrence of sockeye above the Raft River.
Raft R.	1981	Scott et al, 1982	Foot and Float Surveys	Spawners were distributed fairly evenly between the mouth and km 3.1; thereafter, no sightings were made.
North Thompson R.	1981	Scott et al, 1982	Ground and Aerial Surveys	Spawning was observed between the Little Fort area and Clearwater. The majority of spawners appeared to be 5.3 to 8.7 km upstream of Little Fort.

PINK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST	
Mathers Ck. (Incl. tribs.)	1978	Glova et al, 1979	Foot and Float Surveys	The most heavily-used areas for spawning were from km 0 to 1.9 and km 3.3 to 7.3 in the mainstem, and from km 0 to 1.9 in Fukawa Creek. Spawning was most concentrated in Fukawa Creek between km 0.1 and 0.2.
	1979	Grant and McCart, 1980	Foot, Float and Helicopter Surveys	Spawning was observed in the lower portion of the stream.
Kitlope R.	1981	Rosberg et al, 1982	Helicopter, Fixed-Wing, Boat and Foot Surveys	Holding fish were observed in a pool 1.5 km below the Gamsby River confluence. Spawning was reported in a small, tidal tributary near the mouth and in several other locations to km 27. All spawning above the Kitlope Lake outlet was restricted to side channels.
Kemano R.	1979	Murray and Hamilton, 1981	Ground and Aerial Surveys	Pink salmon spawned from km 3.0 to 5.5 and 6.3 to 7.8 in the mainstem and in Horetzky Creek. Numbers of mainstem spawners were roughly equivalent to those in Horetzky Creek.
Kwatna R.	1983	Rice, 1984	Foot, Float, Boat, Helicopter	Extensive use was made of the mainstem for spawning, from the mouth to approximately km 20. About 65$ of the total Kwatna drainage population spawned in the mainstem between kms 7.5 and 14.0. Generally, suitable habitats throughout the river course were fully utilized, with those occurring in more downstream areas being over-utilized. Highest spawning densities and redd superimposition occurred in the mainstem near the mouths of both Oak-Beck and Slousiska Creeks.
Gus Ck.	1983	Rice, 1984	Foot, Helicopter	Intensive spawning occurred over the lower 200 m of this stream.
Oak-Beck Ck.	1983	Rice, 1984	Foot, Helicopter	Spawning took place over the lower 2 km of this stream. Redd superimposition was observed and, as pink and chum spawning occurred over a similar area interspecific competition for spawning gravel also occurred. Oak-Beck Creek was inaccessible to pink migrants past km 2.0.
Slousiska Ck.	1983	Rice, 1984	Foot, Helicopter	All spawning was confined to the lower 560 m of stream, where utilization was heavy throughout. Only limited redd superimposition was evident.
Glacier Ck.	1983	Rice, 1984	Foot, Helicopter	Utilization over the lower 300 m of this stream (the accessible portion) was rated as high. For the past several years pinks have not been observed in this creek.
McNally Ck.	1983	Rice, 1984	Foot, Helicopter	Although no actual spawning was observed, a limited number of pinks were observed holding near the creek mouth. This stream had little potential for spawning.

PINK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			NORTH COAST - Cont'd	
Quatlena R.	1983	Rice, 1984	Foot, Helicopter	Holding fish were found over the lower 2 km of stream but spawning was observed only in the lower 0.8 km. Spawning area use was rated as moderate to heavy.
Nootum R.	1983	Rice, 1984	Foot, Boat, Helicopter	Spawning occurred over the lower 8 km of stream, with density of spawners generally very low. Sixty five percent of the population spawned between km 2.5 and 3.5. The area between approx. km 2.0 and 3.5 potentially support a higher level of use.
			SOUTH COAST	
Kakweiken R.	1981	Slaney and Milko, 1982	Foot and Float Surveys	Holding occurred in large pools below the cascades near the mouth of Lower Kakweiken Lake. Pinks spawned throughout the system to 3 km above Kakweiken Lake. Except for a short section located at km 5.4, which was used as a holding area, the entire stream below Lower Kakweiken Lake was used heavily for spawning. Spawning also occurred in several of the tributaries and, in particular, Elbow Creek, where moderate activity was noted to 1.0 km from the mouth.
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	Holding fish were found predominantly in pools between 0.4 and 1.1 km from the mouth. Spawning was well-distributed and of moderate intensity from km 1.1 to 4.4 and from km 6.6 to 8.0; elsewhere, spawning activity was scattered or nil. Many of the redds dug early in the run were later dessicated when water levels dropped.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Limited spawning habitat resulted in a prolonged spawning period as large numbers of holding fish continually replaced those on the spawning grounds. Spawning intensity was high throughout Glendale Creek from the mouth to a point 0.5 km downstream from the outlet of Glendale Lake. Holding pools were distributed throughout.
Mussel Ck.	1981	Fielden and Slaney, 1982	Foot, Float and Helicopter Surveys	Holding fish were distributed in pools to km 1.6 while scattered spawning was observed from km 1.6 to 2.5 and from km 4.5 to 5.7, the former area containing the bulk of the population.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Approximately 90% of the population spawned between km 4.0 and 5.7. Some spawning was also carried out from the mouth to km 2.5.
Klinaklini R.	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	No pinks were observed in the mainstem. Spawning was conducted largely in Dice Creek, where all but one individual were sighted; this exception was found in Link Channel.

PINK SPAWNER DISTRIBUTIONS

STREAM	YEAR	SOURCE	METHODS	PARTICULARS OF HOLDING AND SPAWNING
			SOUTH COAST - Cont'd	
Ahnuhati R.	1981	Fielden and Slaney, 1982	Float, Foot and Helicopter Surveys	Spawners tended to take advantage of the gentler flow character of the lower reaches and 90% of the population spawned between km 1.6 and 5.1. No spawning was observed between km 5.3 and 8.3 and scattered spawning was documented to km 10.7.
	1983	Whelen and Morgan, 1984	Foot and Helicopter Surveys	Holding areas were numerous throughout the lower 5.6 km of this stream. Spawners utilized the Ahnuhati between km 0.7 and 10.7 with 56% of the population spawning between km 3.5 and 6.0. The increased use of upstream habitats for spawning (over 1981) may have resulted from the large escapement in 1983.
Kwalate Ck.	1981	Fielden and Slaney, 1982	Foot and Helicopter Surveys	All spawning activity took place below the first set of rapids near the mouth.
Sucwoa R.	1978	Glova and McCart, 1979	Foot Surveys	Spawning occurred between the mouth and km 1.6. In addition, intensive use was made of tributary "A".
			FRASER R., N.B.C. and YUKON	
Adams R.	1981	Whelen and Olmsted, 1982	Foot, Float, Boat and Helicopter Surveys	Spawning was conducted between km 0.5 and 2.3 approximately with only limited numbers of fish observed.
South Thompson R.	1981	Whelen and Olmsted, 1982	Foot, Float, Boat and Helicopter Surveys	The greatest proportion of spawners were observed between 0.5 and 2.7 km below Little Shuswap Lake. Spawners were also observed between 7.7 and 10.2 km downstream from Little Shuswap Lake and in the outlet area of Little Shuswap Lake.
North Thompson R.	1981	Scott et al, 1982	Foot and Helicopter Surveys	A side channel located 0.5 km below Little Fort was the only location extensively used for spawning. Single carcasses were discovered from both the area between Little Fort and Joseph Creek and the area between Mann Creek and Blackpool.

APPENDIX C-3

Comparison of SPAWNING ESTIMATES Obtained During New Projects (NP) Studies with Stream File (SF) Information

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Estimates of spawner abundance were extracted directly from the source reports and are compared with SF information for the same year, species and river wherever possible. Where the consultant provided two or more estimates as a result of using several field techniques, the estimate which the consultant had the most confidence in was chosen.

COMPARISON OF CHINOOK SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				NORTH COAST			
Morice R.	1978 1979 1980	6000 4100 4500	Smith and Berezay, 1983 Smith and Berezay, 1983 Smith and Berezay, 1983	based on aerial count based on aerial and boat counts based on aerial counts	6000 no report 4500		5890 (1700-12000) 5790 (1700-12000) 5790 (1700-12000)
Kitlope R.	1981	763-844	Rosberg et al, 1982	guess, based on ground and aerial surveys	800		2200 (1000-5500)
Gamsby R.	1981	50-100	Rosberg et al, 1982	guess, based on ground and aerial surveys	——— Included in Kitlope ———		
Tezwa R.	1981	50-75	Rosberg et al, 1982	guess, based on ground and aerial surveys	——— Included in Kitlope ———		
Kaitan Ck.	1981	<25	Rosberg et al, 1982	guess, based on ground and aerial surveys	——— Included in Kitlope ———		
Kowesas R.	1981	50-100	Rosberg et al, 1982	guess, based on ground and aerial surveys	60		63 (20-200)
Tsaytis R.	1981	<20	Rosberg et al, 1982	guess, based on ground and aerial surveys	20		24 (0-70)
Kemano R. (incl. tribs.)	1979	75	Murray and Hamilton, 1981	carcass recovery	1000		1575 (500-3500)
Kwatna R. (incl. tribs.)	1983	25	Rice, 1984	visual observation, carcass recovery	50		237 (20-750)
				SOUTH COAST			
Kakweiken R.	1981	18*	Slaney and Miliko, 1982	fishway counts	200		392 (25-750)
Glendale/Tom Browne Cks.	1983	2	Whelen and Morgan, 1984	ground count	2		0 (NA****)
Mussel Ck.	1981 1983	950 1120	Fielden and Slaney, 1982 Whelen and Morgan, 1984	float and foot observations ground and aerial counts	1000 -	Included in Klinaklini	
Klinaklini R.	1983	100	Whelen and Morgan, 1984	-	1200		4611 (500-7500)
Ahnuhati R.	1981 1983	200 115	Fielden and Slaney, 1982 Whelen and Morgan, 1984	ground and aerial counts -	N/O**		81-(0-400) 101 (0-400)
Sucwoa R.	1978	981	Glova and McCart, 1979	mark and recovery	NR***		190 (20-400)
Canton Ck.	1978	500-600	Glova and McCart, 1979	visual estimate	N/O		250 (25-500)
Conuma R.	1978	300-500	Glova and McCart, 1979	based on ground counts	500		484 (75-1500)

* only a portion of this run was sampled.
** none observed.
*** none reported.
**** not applicable.

COMPARISON OF CHINOOK SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
SOUTH COAST - Cont'd							
Tlupana R.	1978	7	Glova and McCart, 1979	carcass recovery total	NR		30 (20-75)
Deserted Ck.	1978	827	Glova and McCart, 1979	mark and recovery	200		197 (75-400)
Nitinat R.	1979	15599	McCart et al, 1980	mark and recovery	3500		1270 (750-3000)
Little Qualicum R.	1978	10	Lister, 1979	highest daily live count	30		365 (75-750)
FRASER R., N.B.C. AND YUKON							
Holmes R.	1981	325	Rosberg and Aitken, 1982	carcass recovery, aerial & ground counts	400		338 (75-750)
Morkill R.	1981	95	Rosberg and Aitken, 1982	carcass recovery, aerial & ground counts	150		216 (150-300)*
Torpy R.	1981	510	Rosberg and Aitken, 1982	carcass recovery, aerial & ground counts	510		485 (200-750)
West Torpy R.	1981	150	Rosberg and Aitken, 1982	carcass recovery, aerial & ground counts	Included in Torpy River		
Walker Ck.	1981	480	Rosberg and Aitken, 1982	carcass recovery, aerial & ground counts	140		194 (160-200)**
Slim Ck.	1980 1981	2050 2395	Murray et al, 1981 Rosberg and Aitken, 1982	helicopter & boat average of aerial & carcass recovery totals	1455 1335	helicopter	1092 (750-1900) 1221 (750-1900)
Bowron R.	1980	2000	Murray et al, 1981	comparison of carcass recovery rate with previous mark/recovery studies	1300		1440 (800-3500)
Willow R. (Incl. Wansa Ck.)	1980	1060	Murray et al, 1981	as above	150		172 (75-750)
Stuart R.	1980	1837	Hickey and Lister, 1981	mark & recovery	426		513 (75-1000)
Nechako R. (Incl. tribs.)	1979	1467	Olmsted et al, 1980	aerial count	1800		1100 (400-2600)
West Road (Blackwater R.)	1980	83	Olmsted et al, 1981	aerial count	900		1070 (400-1900)
Baezaeko R.	1980	87	Olmsted et al, 1981	aerial count	——— Included in West Road R. ———		

NR - no report.

* - population assessment difficult in some years due to high glacial turbidity, the likely result being low estimates.

** - creek not normally inspected by Fishery Officer, rather, escapements are estimates supplied by non-departmental sources and are of dubious reliability.

COMPARISON OF CHINOOK SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
FRASER R., N.B.C. AND YUKON - Cont'd							
Cllsbako R.	1980	1	Olmsted et al, 1981	aerial count	——— Included in West Road R. ———		
Nazko R.	1980	192	Olmsted et al, 1981	aerial count	——— Included in West Road R. ———		
Cottonwood R.	1980	151	Olmsted et al, 1981	aerial count	300		165 (75-300)
Mitchell R.	1980	1	Olmsted et al, 1981	aerial count	NR		25 (25)
Horsefly R.	1979 1980	115 206	Olmsted et al, 1980 Olmsted et al, 1981	aerial count aerial count, carcass recovery + live samples	350 250		253 (75-750) 268 (75-750)
McKinley Ck.	1980	102	Olmsted et al, 1981	aerial count + carcass recovery	——— Included in Horsefly R. ———		
Cariboo R.	1980	35	Olmsted et al, 1981	aerial count	——— Included in Horsefly R. ———		
Quesnel R.	1979 1980	800 791	Olmsted et al, 1980 Olmsted et al, 1980	aerial count aerial count	900 950	Fixed wing Fixed wing	1125 (900-1800) 1105 (900-1800)
Eagle R.	1981	305	Whelen and Olmsted, 1982	spawning effort/turnover rate	300		401 (250-756)
Salmon R.	1981	272	Whelen and Olmsted, 1982	spawning effort/turnover rate	300		256 (150-400)
Adams R. (lower)	1981	870	Whelen and Olmsted, 1982	spawning effort/turnover rate	750		1320 (350-2200)
South Thompson R.	1981	8930	Whelen and Olmsted, 1982	spawning effort/turnover rate	6000		4460 (1500-7000)
Finn Ck.	1981	878	Scott et al, 1982	mark and recovery	1000		515 (295-750)
Raft R.	1981	321	Scott et al, 1982	mark and recovery	200		203 (121-260) .
North Thompson R.	1981	2980	Scott et al, 1982	carcass recovery efficiency estimates/ stream section			1435 (750-2500)

COMPARISON OF COHO SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				NORTH COAST			
Mathers Ck.	1978 1979	5000-10000 1000-2000	Glova et al, 1979 Grant and McCart, 1980	float and foot surveys est. for early portion of run	10000		5889 (0-10000)
Kitlope R.	1981	400	Rosberg et al, 1982	guess, based on ground counts and aerial surveys	2000		2800 (2000-4000)
Gamsby R.	1981	7325	Rosberg et al, 1982	guess, based on ground counts and aerial surveys	——— Included in Kitlope ———		
Tezwa R.	1981	50-75	Rosberg et al, 1982	guess, based on ground counts and aerial surveys	——— Included in Kitlope ———		
Kalitan Ck.	1981	1000	Rosberg et al, 1982	guess, based on ground counts and aeiral surveys	——— Included in Kitlope ———		
Kowesas R.	1981	1350	Rosberg et al, 1982	guess, based on ground counts and aerial surveys	N/O		50 (0-100)
Tsaytis R.	1981	4000	Rosberg et al, 1982	guess, based on ground counts and aerial surveys	N/O		75 (0-400)
Kemano R.	1979	39	Murray and Hamilton, 1981	biological samples	3000		5100 (2500-7500)
Kwatna R. (incl. tribs.)	1873	2250	Rice, 1984	visual, carcass recovery	3500		6175 (1250-15000)
Nootum R.	1983	50	Rice, 1984	visual, carcass recovery	25		160 (0-500)
				SOUTH COAST			
Kakweiken R.	1981	2418	Slaney and Milko, 1982	fishway count - not including main channel migrants	7000		7275 (750-10000)
Glendale/Tom Browne Cks.	1981 1983	300 1	Fielden and Slaney, 1982 Whelen and Morgan, 1984	stream and aerial surveys: pre-peak ground count	300 2400		295 (0-2000) 548 (0-2000)
Mussel Ck.	1981 1983	5600 >485	Fielden and Slaney, 1982 Whelen and Morgan, 1984	aerial & ground surveys aerial and ground surveys	500 -		- -*

N/O - none observed.
NR - no report.
* - Included in Klinaklini River.

COMPARISON OF COHO SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
SOUTH COAST - Cont'd							
Kilnakilini R.	1983	460	Whelen and Morgan, 1984	aerial and ground surveys	950		3071 (500-3500)
Ahnuhati R.	1981 1983	1700 1010	Fielden and Slaney, 1982 Whelen and Morgan, 1984	aerial and ground surveys foot surveys	2100 1000		358 (25-500) 578 (200-2100)
Franklin R.	1981	1	Fielden and Slaney, 1982	foot survey?	NR		89 (0-200)
Kwalate Ck.	1981	1050-1350	Fielden and Slaney, 1982	pre-spawning aerial & ground counts	300		580 (100-2000)
Sucwoa R.	1978	132	Glova and McCart, 1979	mark & recovery	NR		385 (150-750)
Canton Ck.	1978	200-300	Glova and McCart, 1979	est. based on ground surveys	N/O		239 (25-750)
Conuma R.	1978	800-1000	Glova and McCart, 1979	guess, based on ground surveys	400		965-(200-3000)
Tlupana R.	1978	800-1000	Glova and McCart, 1979	guess, based on ground surveys	300		348 (75-750)
Deserted Ck.	1978	50-100	Glova and McCart, 1979	single pre-spawning count	N/O		69 (25-200)
Nitinat R.	1979	<1000	McCart et al, 1980	foot surveys?	600		1212 (400-3500)
Little Qualicum R.	1978	455	Lister, 1979	highest daily live count (foot survey)	5500	foot survey	2680 (400-5500)
FRASER R., N.B.C. AND YUKON							
Eagle R. (Incl. South Pass Ck.)	1982	1046	Whelen et al, 1983	spawning effort/turnover rate	1000		1864 (850-3500)
Salmon R. (Incl. Bolean Ck.)	1982	954	Whelen et al, 1983	spawning effort/turnover rate	800		1279 (500-2000)
Adams R. (lower) - Incl. Sinmax Ck. + tribs.	1981 1982	22 83	Whelen and Olmsted, 1982 Whelen et al, 1983	pre-spawning observation (foot survey) spawning effort/turnover rate	100 100		185 (10-338) 170 (10-338)
Adams R. (upper Incl. Cayenne Ck. & Momich R.)	1982	205	Whelen et al, 1983	spawning effort/turnover rate	200		168 (75-475)

* only a portion of this stream was surveyed.

NR - no report.

COMPARISON OF COHO SPAWNING ESTIMATED OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
FRASER R., N.B.C., AND YUKON - Cont'd							
South Thompson R.	1981	1	Whelen and Olmsted, 1982	foot survey?	NR		NR
Albreda R.	1982	61*	Hutton et al, 1983	carcass recovery + final live count - (partial surveys)	550	foot survey	209 (0-500) - prev. 8 yr. avg.
Blue R.	1982	177	Hutton et al, 1983	peak live count (partial survey)	450	foot & float surveys	342 (25-600) - prev. 8 yr. avg.
Lion Ck.	1982	1200	Hutton et al, 1983	est. based on foot surveys	1200	foot surveys	900 (300-2300)
Wire Cache Ck.	1982	110	Hutton et al, 1983	est. based on foot surveys	110	foot surveys	NR
Lemieux Ck.	1982	400	Hutton et al, 1983	est. based on foot surveys	400	foot surveys	446 (180-750)
Barriere R.	1982	450	Hutton et al, 1983	est. based on foot surveys & Fishery Officers counts	450		383 (60-750)
East Barriere R.	1982	2	Hutton et al, 1983	single foot survey	75		60 (18-120)
Louis Ck. (Incl. Christian Ck.)	1982	750	Hutton et al, 1983	estimate based on ground surveys and Fishery Officers counts	750	foot surveys	383 (60-750)
Coldwater R.	1982	194	Whelen et al, 1983	spawning effort/turnover rate	300		450 (70-1500)

NR - no record.

COMPARISON OF CHUM SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				NORTH COAST			
Mathers Ck.	1978 1979	1135 50-75	Glova et al, 1979 Grant and McCart, 1980	float and foot surveys estimate based on ground and aerial surveys	1000		6700 (500-17500)
Kitlope R.	1981	500-1000	Rosberg et al, 1982	estimate based on ground and aerial surveys	75		795 (0-3500)
Gamsby R.	1981	100-150	Rosberg et al, 1982	estimate based on ground and aerial surveys	Included in Kitlope River		
Kowesas R.	1981	<50	Rosberg et al, 1982	estimate based on ground and aerial surveys	25		99 (0-500)
Tsaytis R.	1981	100	Rosberg et al, 1982	estimate based on ground and aerial surveys	50		132 (0-500)
Kemano R. (incl. tribs.)	1979	15000-22500	Murray and Hamilton, 1981	adjusted aerial & ground counts	20000		45900 (12500-100000)
Kwatna R. (incl. tribs.)	1983	3175	Rice, 1984	visual, carcass recovery	5500		8500 (2500-25000)
Quatlena R.	1983	100	Rice, 1984	visual, carcass recovery	40		264 (0-800)
Nootum R.	1983	50	Rice, 1984	visual, carcass recovery	200		288 (0-800)
				SOUTH COAST			
Kakweiken R.	1981	2000	Slaney and Milko, 1982	aerial and ground surveys	300-500		4744 (400-12000)
Glendale Ck.	1981 1983	500 2139	Fielden and Slaney, 1982 Whelen and Morgan, 1984	stream surveys mean of visual est. observed & calculated	300 2100		6330 (400-40000) 5020 (300-40000)
Mussel Ck.	1981 1983	300 80	Fielden and Slaney, 1982 Whelen and Morgan, 1984	stream float and foot surveys aerial and ground surveys	300		-
Klinaklini R.	1983	600	Whelen and Morgan, 1984	aerial and ground surveys	700		11471 (300-30000)
Ahnuhati R.	1981 1983	3000 7680	Fielden and Slaney, 1982 Whelen and Morgan, 1984	stream float and foot surveys mean of observed escapement and observed turnover rate	3000 6400		4480 (1000-12000) 4730 (1000-12000)

COMPARISON OF CHUM SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				SOUTH-COAST - Cont'd			
Kwalate Ck.	1981	200	Fielden and Slaney, 1982	single foot survey	200		110 (0-300)
Sucwoa R.	1978	17865	Glova and McCart, 1979	mark and recovery	NR		4175 (750-8000)
Canton Ck.	1978	5526	Glova and McCart, 1979	mark and recovery	800		1825 (400-3500)
Conuma R.	1978	23236	Glova and McCart, 1979	mark and recovery	7500		6880 (3500-15000)
Tlupana R.	1978	9660	Glova and McCart, 1979	mark and recovery	3500		2920 (200-6000)
Deserted Ck.	1978	35000	Glova and McCart, 1979	visual estimate	9000		4222 (3500-7500)
Nitinat R.	1979	10049	McCart et al, 1980	mark and recovery	4000		62400 (4000-230000)
Little Qualicum R.	1978	162400	Lister, 1979	mark and recovery	75000		56364 (22500-104775)

COMPARISON OF SOCKEYE SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				NORTH COAST			
Kitlope Lake	1981	400-500	Rosberg et al, 1982	estimate based on aerial & ground surveys	Included in Kitlope R.		
Tezwa R.	1981	5000-6000	Rosberg et al, 1982	estimate based on aerial & ground surveys	Included in Kitlope R.		
Kalitan Ck.	1981	7000-8000	Rosberg et al, 1982	estimate based on aerial & ground surveys	Included in Kitlope R.		
Kowesas R.	1981	<10	Rosberg et al, 1982	estimate based on aerial & ground surveys	N/O		0 (0)
Kemano R. (incl. tribs.)	1979	2	Murray and Hamilton, 1981	carcass recovery total	25		75 (0-400)
Kwatna R. (incl. tribs.)	1983	250	Rice, 1984	visual, carcass recovery	100		8 (0-50)
				SOUTH COAST			
Katwelken R.	1981	500	Slaney and Milko, 1982	fishway counts	300-500		353 (0-1200)
Glendale/Tom Browne Cks.	1981 1983	5 6	Fielden and Slaney, 1982 Whelen and Morgan, 1984	foot survey aerial and ground surveys	N/O 6		67 (0-200) 57 (0-200)
Mussel Ck.	1981 1983	50 150	Fielden and Slaney, 1982 Whelen and Morgan, 1984	foot survey aerial and ground surveys	Included in Klinaklini River		
Klinaklini R.	1983	100	Whelen and Morgan, 1984	aerial and ground surveys	220		719 (0-1500)
Ahnuhati R.	1981 1983	6 10	Fielden and Slaney, 1982 Whelen and Morgan, 1984	foot survey maximum aerial count	NR 10		NR 18 (0-75)
Sucwoa R.	1978	323	Glova and McCart, 1979	mark and recovery	NR		36 (25-75)
Canton Ck.	1979	50-100	Glova and McCart, 1979	estimate based on ground surveys	75		25 (25)
Conuma R.	1978	100	Glova and McCart, 1979	mark and recovery	400		231 (25-750)
Tlupana R.	1978	present	Glova and McCart, 1979	ground surveys	NR		40 (25-70)
Deserted Ck.	1978	<100	Glova and McCart, 1979	estimate based on ground surveys	10		120 (25-500)
Nitinat R.	1979	6	McCart et al, 1980	foot survey?	80		33 (25-50)

COMPARISON OF SOCKEYE SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				FRASER R., N.B.C. and YUKON			
Little Qualicum R.	1978	24	Lister, 1979	foot survey	45		75 (25-200)
Bowron R.	1980	present	Murray et al, 1981	foot surveys	3500		8245 (1350-25000)
Nechako R. (incl. tribs.)	1979	40	Olmsted et al, 1980	foot surveys	NR		NR
Mitchell R.	1980	8	Olmsted et al, 1981	aerial survey	N/O		82880 (0-4000)
Horsefly R.	1979 1980	present 175	Olmsted et al, 1980 Olmsted et al, 1981	- stream float	400 150		103765 (200-475000) 72805 (200-475000)
McKinley Ck.	1980	85	Olmsted et al, 1981	aerial count	——— Included In Horsefly R. ———		
Quesnel R.	1980	20	Olmsted et al, 1981	aerial count	NR		NR
Adams R. (lower)	1981	2000	Whelen and Olmsted, 1982	highest aerial count	31000		223,232 (2500-1480600
South Thompson R.	1981	2480	Whelen and Olmsted, 1982	highest aerial count	200		1678 (0-9800)
Finn Ck.	1981	7	Scott et al, 1982	foot surveys	8		NR
Raft R.	1981	579	Scott et al, 1982	counting fence	600		3618 (525-12000)
North Thompson R.	1981	200	Scott et al, 1982	foot surveys	600		411 (0-1500)

COMPARISON OF PINK SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				NORTH COAST			
Mathers Ck.	1978 1979	25000-40000 150-200	Glova et al, 1979 Grant and McCart, 1980	float and foot surveys ground counts	50000		29750 (0-75000)
Morice R.	1979	73	Smith and Berezay, 1983	biological sample total	NR		9730 (100-50000)
Kitlope R.	1981	200-300	Rosberg et al, 1982	estimate based on aerial & ground surveys	100		565 (0-2500) -S.F. totals include Gramsby & Tezwa systems
Kemano R.	1979	15000-20000	Murray and Hamilton, 1981	aerial and ground surveys	40000		71075 (750-200000)
Kwatna R. (incl. tribs.)	1983	2000000	Rice, 1984	visual, carcass recovery	2000000		61000 (0-125000)
Quatlena R.	1983	5000	Rice, 1984	visual, carcass recovery	4000		614 (0-2000)
Nootum R.	1983	1000	Rice, 1984	visual, carcass recovery	2000		1574 (0-6000)
				SOUTH COAST			
Kakweiken R.	1981	575000-600000	Slaney and Milko, 1982	estimate based on fishway counts	600000		263200 (15000-800000)
Glendale/Tom Browne Cks.	1981 1983	20000 300000	Fielden and Slaney, 1982 Whelen and Morgan, 1984	estimate based on ground & aerial surveys approximation between visual and calculated (turnover rate) estimates	20000 300000		107400 (16000-200000) - odd years 81400 (16000-200000) - odd years
Mussel Ck.	1981 1983	16 200	Fielden and Slaney, 1982 Whelen and Morgan, 1984	single ground survey count aerial and ground surveys	Included in Klinaklini		
Klinaklini R.	1983	25	Whelen and Morgan, 1984	aerial and ground surveys	225		99 (20-300)
Ahnuhati R.	1981 1983	4000-5000 9872	Fielden and Slaney, 1982 Whelen and Morgan, 1984	aerial, streamside and float surveys aerial surveys	7000 9000		61250 (3000-340000) 69800 (3000-340000)
Kwalate Ck.	1981	750-1000	Fielden and Slaney, 1982	single foot survey	1000		54 (0-100)
Sucwoa R.	1978	945	Glova and McCart, 1979	mark and recovery	NR		1733 (200-3500)
Canton Ck.	1978	110	Glova and McCart, 1979	mark and recovery	N/O		700 (25-1500)

COMPARISON OF PINK SPAWNING ESTIMATES OBTAINED DURING NEW PROJECTS (NP) STUDIES WITH STREAM FILE (SF) INFORMATION

STREAM	YEAR	N.P. EST.	SOURCE	METHODS	S.F. EST.	METHODS	10 YR. AVG. + RANGE
				SOUTH COAST - Cont'd			
Conuma R.	1978	<1000	Glova and McCart, 1979	estimate based on foot surveys	1000		1636 (25-7500)
Tlupana R.	1978	present	Glova and McCart, 1979	ground surveys	100		63 (0-200)
Deserted Ck.	1978	<100	Glova and McCart, 1979	foot surveys	50		1021 (25-3951)
				FRASER R., N.B.C. and YUKON			
Adams R. (lower)	1981	45	Whelen and Olmsted, 1982	foot and aerial surveys	1100		269 (-) -odd years
South Thompson R.	1981	1370	Whelen and Olmsted 1982	highest aerial count	1560		267 (25-1000)
North Thompson R.	1981	25	Scott et al, 1982	foot surveys	20		

APPENDIX C-4

SEX RATIOS of Stocks Sampled

Although the male:female (M:F) ratio often was assumed to be 1:1, most of the New Projects studies assessed this factor by objective means. The sex ratios detailed here have been standardized from the data provided in the source report so that jacks are included in the male population. In cases where more than one gear type was used to obtain samples, an overall average using the total number of fish also was derived.

SEX RATIOS OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
			NORTH COAST			
Morice R.	1978	Smith & Berezay, 1983	Carcass Recovery	71	0.54:1	1.85:1
	1979	Smith & Berezay, 1983	Carcass Recovery	308	1.03:1	0.97:1
	1980	Smith & Berezay, 1983	Carcass Recovery	266	0.48:1	2.08:1
Kitlope R.	1981	Rosberg et al, 1982	Carcass Recovery	55	1.39:1	0.72:1
			Live Count	40	0.67:1	1.50:1
			Overall	95	1.02:1	0.98:1
Kemano R.	1979	Murray & Hamilton, 1981	Carcass Recovery	85	0.83:1	1.21:1
			SOUTH COAST			
Mussel Ck.	1981	Fielden & Slaney, 1982	Carcass Recovery	35	1.92:1	0.52:1
	1983	Whelen & Morgan, 1984	Angling	273	0.73:1	1.37:1
			Carcass Recovery	26	7.67:1	0.13:1
			Counting Fence	14	2.50:1	0.40:1
			Overall	313	0.90:1	1.11:1
Kilnaklini R.	1983	Whelen & Morgan, 1984	Carcass Recovery	4	0.30:1	3.3:1
			Angling	1	1:0	0:1
			Overall	5	0.67:1	1.50:1
Ahnuhati R.	1983	Whelen & Morgan, 1984	Carcass Recovery	16	0.60:1	1.67:1
			Angling	7	2.50:1	0.40:1
			Overall	23	0.92:1	1.09:1
Sucwoa R.	1978	Giova & McCart, 1979	Seining	92	3.01:1	0.33:1
			Carcass Recovery	128	1.67:1	0.60:1
			Overall	220	2.01:1	48.1:1
Canton Ck.	1978	Giova & McCart, 1979	Seining	27	27:0	0:27
			Carcass Recovery	13	3.33:1	0.30:1
			Overall	40	12:33:1	0.08:1
Conuma R.	1978	Giova & McCart, 1979	Carcass Recovery	89	1.54:1	0.65:1
Tlupana R.	1978	Giova & McCart, 1979	Carcass Recovery	7	1.33:1	0.75:1
Deserted Ck.	1978	Giova & McCart, 1979	Seining	34	2.40:1	0.42:1
			Carcass Recovery	73	1.28:1	0.78:1
			Overall	107	1.55:1	0.65:1
Nitinat R.	1979	McCart et al, 1980	Seining	502	1.08:1	0.92:1
			Carcass Recovery	1900	1.05:1	0.96:1
			Overall	2402	1.05:1	0.95:1
Little Qualicum R.	1978	Lister, 1979	Carcass Recovery	9	1.25:1	0.80:1
			FRASER R., N.B.C., and YUKON			
Holmes R.	1981	Rosberg & Aitken, 1982	Carcass Recovery	12	0.50:1	2.0:1
Torpy R.	1981	Rosberg & Aitken, 1982	Carcass Recovery	38	0.65:1	1.53:1
West Torpy R.	1981	Rosberg & Aitken, 1982	Carcass Recovery	17	0.70:1	1.43:1
Walker Ck.	1981	Rosberg & Aitken, 1982	Carcass Recovery	65	0.97:1	1.03:1
Slim Ck.	1980	Murray et al, 1981	Carcass Recovery	146	0.36:1	2.74:1
	1981	Rosberg & Aitken, 1982	Carcass Recovery	268	0.83:1	1.21:1
Bowron R.	1980	Murray et al, 1981	Carcass Recovery	177	0.45:1	2.22:1
Willow R.	1980	Murray et al, 1981	Carcass Recovery	63	0.40:1	2.50:1
Wansa Ck.	1980	Murray et al, 1981	Carcass Recovery	36	0.13:1	8.0:1
Stuart R.	1980	Hickey & Lister, 1981	Carcass Recovery	1226	0.62:1	1.62:1
			Seining	105	1.33:1	0.75:1
			Overall	1331	0.66:1	1.52:1
Nechako R.	1979	Olmsted et al, 1980	Angling	27	0.80:1	1.25:1
			Carcass Recovery	17	1.13:1	0.89:1
			Overall	44	0.91:1	1.10:1
West Road (Blackwater R.)	1980	Olmsted et al, 1981	Angling	17	2.40:1	0.40:1
Nazko R.	1980	Olmsted et al, 1981	Angling	10	1.50:1	0.67:1
Cottonwood R.	1980	Olmsted et al, 1981	Angling	7	1.33:1	0.75:1
			Carcass Recovery	2	0:2	2.0:0
			Overall	9	0.57:1	1.75:1
McKinley Ck.	1980	Olmsted et al, 1981	Angling	15	2.75:1	0.36:1
			Carcass Recovery	4	0.33:1	3.0:1
			Overall	19	1.71:1	0.58:1
Horsefly R.	1979	Olmsted et al, 1980	Angling	45	0.73:1	1.36:1
			Carcass Recovery	12	0.33:1	3.0:1
			Overall	57	0.58:1	1.71:1
	1980	Olmsted et al, 1981	Angling	46	1.19:1	0.84:1
			Carcass Recovery	12	0.20:1	5.0:1
			Overall	58	0.87:1	1.18:1

SEX RATIOS OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
		FRASER R., N.B.C., and YUKON - Cont'd				
Quesnel R.	1979	Olmsted et al, 1980	Angling	65	2.10:1	0.48:1
			Carcass Recovery	66	0.74:1	1.36:1
			Overall	131	1.22:1	0.82:1
	1980	Olmsted et al, 1981	Angling	296	1.04:1	0.96:1
			Carcass Recovery	85	0.39:1	2.54:1
			Overall	381	0.85:1	1.18:1
Eagle R.	1981	Whelen & Olmsted, 1982	Angling	41	1.28:1	0.78:1
			Carcass Recovery	84	0.65:1	1.55:1
			Overall	125	0.81:1	1.23:1
Salmon R.	1981	Whelen & Olmsted, 1982	Angling	33	1.20:1	0.83:1
			Carcass Recovery	43	0.23:1	4.38:1
			Fence	22	0.83:1	1.20:1
			Overall	98	0.58:1	1.72:1
Adams R. (lower)	1981	Whelen & Olmsted, 1982	Carcass Recovery	122	0.54:1	1.84:1
South Thompson R.	1981	Whelen & Olmsted, 1982	Carcass Recovery	817	0.21:1	4.88:1
Finn Ck.	1981	Scott et al, 1982	Fence	128	0.91:1	1.1:1
			Angling	510	1.81:1	0.85:1
			Carcass Recovery	40	1.67:1	0.60:1
			Overall	678	1.15:1	0.87:1
Raft R.	1981	Scott et al, 1982	Fence	67	2.05:1	0.49:1
			Carcass Recovery	261	1.61:1	0.62:1
			Overall	328	1.69:1	0.59:1
North Thompson R.	1981	Scott et al, 1982	Seining	23	3.60:1	0.28:1
			Carcass Recovery	419	0.96:1	1.04:1
			Overall	442	1.02:1	0.98:1

SEX RATIOS OF COHO STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
NORTH COAST						
Methers Ck.	1978 1979	Glova et al, 1979 Grant & McCart, 1980	Seining Fence	78 10	2.55:1 1.50:1	0.39:1 0.67:1
Kemano R.	1979	Murray & Hamilton, 1981	Carcass Recovery	39	0.85:1	1.17:1
Kwatna R.	1983	Rice, 1984	Angling[1]	90	1.6:1[2]	0.6:1[2]
SOUTH COAST						
Kakweiken R.	1981	Slaney & Miko, 1982	Fishway	326	1.17:1	0.85:1
Mussel Ck.	1983	Whelen & Morgan, 1984	Fence Angling Carcass Recovery Overall	48 35 1 84	2.43:1 2.18:1 1:0 2.36:1	0.41:1 0.46:1 0:1 0.43:1
Klinaklini R.	1983	Whelen & Morgan, 1984	Angling Carcass Recovery Overall	12 1 13	3.0:1 1:0 3.33:1	0.33:1 0:1 0.30:1
Ahnuhati R.	1983	Whelen & Morgan, 1984	Angling	14	6.0:1	0.17:1
Sucwoa R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	44 3 47	1.44:1 3:0 1.61:1	0.69:1 0:3 0.62:1
Canton Ck.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	25 2 27	1.50:1 0:2 1.25:1	0.67:1 2:0 0.8:1
Conuma R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	52 11 63	0.86:1 1.75:1 0.97:1	1.17:1 0.57:1 1.03:1
Deserted Ck.	1978	Glova & McCart, 1979	Carcass Recovery	12	1:1	1:1
Nitinat R.	1979	McCart et al, 1980	Seining Carcass Recovery Overall	4 40 44	3.0:1 0.48:1 0.57:1	0.33:1 2.08:1 1.75:1
Little Qualicum R.	1978	Lister, 1979	Carcass Recovery	63	1.42:1	0.70:1
FRASER R., N.B.C., and YUKON						
Eagle R. (Incl. South Pass Ck.)	1982	Whelen et al, 1983	Angling Carcass Recovery Overall	71 132 203	0.61:1 0.61:1 0.61:1	1.63:1 1.64:1 1.64:1
Salmon R. (Incl. Bolean Ck.)	1982	Whelen et al, 1983	Angling Carcass Recovery Overall	48 30 78	1.29:1 2.0:1 1.52:1	0.78:1 0.50:1 0.66:1
Adams R. (lower) (Incl. Sinmax Hiuihill and Nikwikwaia Cks.)	1982	Whelen et al, 1983	Angling Carcass Recovery Overall	19 6 25	1.38:1 0.50:1 1.08:1	0.73:1 2.0:1 0.92:1
Adams R. (upper) (Incl. Momich R. and Cayenne Ck.)	1982	Whelen et al, 1983	Angling Carcass Recovery Overall	16 3 19	1.67:1 0:3 1.11:1	0.60:1 3:0 0.90:1
Albreda R.	1982	Hutton et al, 1983	Carcass Recovery	17	0.89:1	1.13:1
Lion Ck.	1982	Hutton et al, 1983	Carcass Recovery	917	0.53:1	1.87:1
Wire Cache Ck.	1982	Hutton et al, 1983	Carcass Recovery	70	0.84:1	1.19:1
Lemieux Ck.	1982	Hutton et al, 1983	Carcass Recovery	183	0.61:1	1.65:1
Barriere R.	1982	Hutton et al, 1983	Carcass Recovery	51	0.31:1	3.25:1
Louis Ck.(Incl. Christian Ck)	1982	Hutton et al, 1983	Carcass Recovery	204	1.02:1	0.98:1
Coldwater R.	1982	Whelen et al, 1983	Angling Carcass Recovery Overall	18 2 20	1.25:1 1:1 1.22:1	0.80:1 1:1 0.82:1

[1] caught by area loggers.

[2] a 1:1 male to female ratio was assumed for the population.

SEX RATIOS OF CHUM STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
NORTH COAST						
Mathers Ck.	1978	Glova et al, 1979	Seining Carcass Recovery Overall	311 278 589	1.41:1 0.81:1 1.08:1	0.71:1 1.24:1 0.92:1
	1979	Grant & McCart, 1980	Seining	10	2.33:1	0.43:1
Kitlope R.	1981	Rosberg et al, 1982	Seining Carcass Recovery Overall	59 38 97	1.46:1 2.45:1 1.63:1	0.69:1 0.41:1 0.61:1
Gamsby R.	1981	Rosberg et al, 1982	Carcass Recovery	19	0.90:1	1.11:1
Kemano R.	1979	Murray & Hamilton, 1981	Carcass Recovery	5474	0.72:1	1.39:1
Kwatna R.	1983	Rice, 1984	Carcass Recovery	349	1.2:1	0.8:1
Quatlena R.	1983	Rice, 1984	Carcass Recovery	55	1.2:1	0.8:1
SOUTH COAST						
Kakweiken R.	1981	Slaney & Milko, 1982	Fishway Carcass Recovery Overall	51 17 68	1.43:1 1.43:1 1.43:1	0.70:1 0.70:1 0.70:1
Glendale/Tom Browne Cks.	1981 1983	Fielden & Slaney, 1982 Whelen & Morgan, 1984	Carcass Recovery Carcass Recovery	24 45	0.60:1 1.50:1	1.67:1 0.67:1
Mussel Ck.	1983	Whelen & Morgan, 1984	Angling	14	6.01:1	0.17:1
Ahnuhati R.	1981 1983	Fielden & Slaney, 1982 Whelen & Morgan, 1984	Carcass Recovery Carcass Recovery	22 109	0.69:1 1.37:1	1.44:1 0.73:1
Sucwoa R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	291 3901 4192	1.69:1 0.73:1 0.77:1	0.59:1 1.38:1 1.30:1
Canton Ck.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	251 1343 1594	1.15:1 0.64:1 0.70:1	0.87:1 1.56:1 1.42:1
Conuma R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	830 5895 6725	1.48:1 0.74:1 0.84:1	0.68:1 1.35:1 1.24:1
Tlupana R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	140 1173 1313	0.82:1 0.77:1 0.78:1	1.22:1 1.29:1 1.29:1
Deserted Ck.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	960 22095 23055	2.53:1 0.77:1 0.96:1	0.40:1 1.30:1 1.24:1
Nitinat R.	1979	McCart et al, 1980	Seining Carcass Recovery Overall	841 3108 3949	1.08:1 0.83:1 0.88:1	0.92:1 1.21:1 1.14:1
Little Qualicum R.	1978	Lister 1979	Carcass Recovery	65046	0.81:1	1.24:1

SEX RATIOS OF SOCKEYE STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
NORTH COAST						
Tezwa R.	1981	Rosberg et al, 1982	Carcass Recovery	10	2.33:1	0.43:1
Kelltan Ck.	1981	Rosberg et al, 1982	Carcass Recovery	205	2.25:1	0.44:1
			Live Collection	221	5.14:1	0.19:1
			Overall	426	3.30:1	0.30:1
Kitlope R.	1981	Rosberg et al, 1982	Seining	2	1:1	1:1
			Carcass Recovery	23	0.77:1	1.30:1
			Overall	25	0.79:1	1.27:1
Kwatna R.	1983	Rice, 1984	Seining	11	1.75:1	0.57:1
SOUTH COAST						
Kakweiken R.	1981	Slaney & Milko, 1982	Fishway	95	1.50:1	0.67:1
Mussel Ck.	1983	Whelen & Morgan, 1984	Fence	4	1:1	1:1
			Angling	3	3:0	0:3
			Carcass Recovery	1	1:0	0:1
			Overall	8	7:1	0.14:1
Sucwoa R.	1978	Glova & McCart, 1979	Seining	153	1.32:1	0.76:1
			Carcass Recovery	38	0.65:1	1.53:1
			Overall	191	1.30:1	0.97:1
Canton Ck.	1978	Glova & McCart, 1979	Seining	22	0.69:1	1.44:1
Conuma R.	1978	Glova & McCart, 1979	Seining	40	1.35:1	0.74:1
			Carcass Recovery	11	1.75:1	0.57:1
			Overall	51	1.43:1	0.70:1

SEX RATIOS OF PINK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	N	M:F	F:M
NORTH COAST						
Kwatna R.	1983[1]	Rice, 1984	Seining Carcass Recovery Overall	595 11737 12332	1.8:1 0.8:1 approx. 0.8:1	0.6:1 1.3:1 approx. 1.3:1
Quatlena R.	1983	Rice, 1984	Carcass Recovery	508	0.9:1	1.1:1
Kitlope R.	1981	Rosberg et al, 1982	Carcass Recovery	24	1:1	1:1
Kemano R.	1979	Murray & Hamilton, 1981	Carcass Recovery	2595	0.45:1	2.19:1
Morice R.	1979	Smith & Berezay, 1983	Carcass Recovery	73	0.62:1	1.61:1
SOUTH COAST						
Keogh/Kokish R.	1981	Slaney & Milko, 1982	Fishway Carcass Recovery Overall	573 333 906	0.85:1 1.87:1 1.22:1	1.17:1 0.53:1 0.82:1
Glendale/Tom Browne Cks.	1981 1983	Fielden & Slaney, 1982 Whelen & Morgan, 1984	Carcass Recovery Carcass Recovery	46 206	1.70:1 0.96:1	0.59:1 1.04:1
Mussel Ck.	1983	Whelen & Morgan, 1984	Carcass Recovery Angling Overall	4 3 7	4:0 2:1 6:1	0:4 0.5:1 0.17:1
Kilnakilni R.	1983	Whelen & Morgan, 1984	Angling Carcass Recovery Overall	18 1 19	0.80:1 0:1 0.73:1	1.25:1 1:0 1.38:1
Annuhati R.	1983	Whelen & Morgan, 1984	Carcass Recovery Angling Overall	135 75 210	1.21:1 0.50:1 0.89:1	0.82:1 2:1 1.38:1
Sucwoa R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	85 289 374	0.70:1 0.45:1 0.50:1	1.43:1 2.21:1 1.99:1
Canton Ck.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	13 22 35	0.86:1 0.69:1 0.75:1	1.17:1 1.44:1 1.33:1
Conuma R.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	1 80 81	0:1 0.31:1 0.31:1	1:0 3.21:1 3.26:1
Deserted Ck.	1978	Glova & McCart, 1979	Seining Carcass Recovery Overall	3 5 8	3:0 4:1 7:1	0:3 0.25:1 0.14:1

[1] a sex ratio of 1M:F was assumed for the population.

APPENDIX C-5

AGE COMPOSITION of Stocks Sampled (expressed as percent)

Age composition data were presented inconsistently between studies and required extensive recalculation in order to employ a standard format. Source report appendices were used as the primary data source and all age sampling data were included wherever possible. Length and age data were rejected if fish were badly decomposed, or if obvious data flaws existed. Regeneration rates were identified within each population studied so that the nonreadable scales (NR) are included only as sample totals --- the overall percent age compositions exclude NR scales. Unless otherwise indicated, ages were derived from scale analysis.

AGE COMPOSITION OF CHINOOK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)											
					2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_2	6_3	NR*
			NORTH COAST													
Morice R.	1978	Smith and Berezay, 1983	M	25	10.0	0	10.0	5.0	10.0	40.0	10.0	15.0	0	0	0	5/25
			F	46	0	0	0	0	35.1	8.1	18.9	35.1	0	0	2.7	9/46
			Total	71	3.5	0	3.5	1.8	26.3	19.3	15.8	28.1	0	0	1.8	14/71
	1979	Smith and Berezay, 1983	M	156	0	0	5.1	2.9	8.8	27.0	8.0	37.2	0	10.9	0	19/156
			F	152	0	0	0.7	0	9.6	2.9	16.2	53.7	0	16.9	0	16/152
			Total	308	0	0	2.9	1.5	9.2	15.0	12.5	45.4	0	13.9	0	35/308
	1980	Smith and Berezay, 1983	M	86	0	0	0	1.6	1.6	6.6	0	75.4	0	13.1	1.6	25/86
			F	180	0	0	0	1.3	2.6	9.7	1.3	75.3	0	9.1	0	26/180
			Total	266	0	0	0	1.4	2.3	8.8	0.9	75.3	0	10.2	0.5	51/266
Kitlope R.	1981	Rosberg et al, 1982	M	21	0	0	0	4.8	4.8	23.8	4.8	28.6	0	33.3	0	NG
			F	12	0	0	0	0	0	0	0	58.3	0	41.7	0	NG
			Total	33	0	0	0	3.0	3.0	15.2	3.0	39.4	0	36.4	0	NG
Kemano R.	1979	Murray and Hamilton, 1981	M	3	0	0	33.3	0	0	66.7	0	0	0	0	0	0
			F	4	0	0	0	0	0	0	100	0	0	0	0	0
			Total	7	0	0	14.3	0	0	28.6	57.1	0	0	0	0	0
			SOUTH COAST													
Mussel Ck.	1981	Fielden and Slaney, 1982	M	16	0	0	0	50.0	0	16.7	0	33.3	0	0	0	10/16
			F	10	0	0	0	0	0	0	12.5	75.0	0	12.5	0	2/10
			Total	26	0	0	0	21.4	0	7.1	7.1	57.1	0	7.1	0	12/26
	1983	Whelen and Morgan, 1984	M	102	1.2	0	2.4	28.2	5.9	45.9	1.2	15.3	0	0	0	17/102
			F[1]	107	0	0	0	0	3.3	5.6	20.0	65.6	0	0	0	17/107
			Total	209	0.6	0	1.1	13.7	4.6	25.1	10.9	41.1	0	0	0	34/209
Ahnuhati R.	1983	Whelen and Morgan, 1984	M	11	0	0	0	11.1	11.1	22.2	0	33.3	11.1	0	11.1	2/11
			F	12	0	0	0	0	0	0	0	40.0	0	60.0	0	2/12
			Total	23	0	0	0	5.3	5.3	10.5	0	36.8	5.3	31.6	5.3	4/23

NG - not given

[1] - 5.6% of this sample were age 6_1 (2.9% of total)

* - not readable

NOTE: unless otherwise indicated, ages were derived from scale analysis

- NR's in all tables are included in sample totals and %'s for aged fish are derived from the sample total less the NR's.

AGE COMPOSITION OF CHINOOK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years) 2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_2	6_3	NR*
SOUTH COAST - Cont'd																
Sucwoa R.	1978	Glova and McCart, 1979	M	29	44.8	0	34.5	0	10.3	0	10.3	0	0	0	0	NG
			F	13	15.4	0	7.7	0	38.5	0	38.5	0	0	0	0	NG
			Total	42	35.7	0	26.2	0	19.0	0	19.0	0	0	0	0	NG
Canton Ck.	1978	Glova and McCart, 1979	M	20	50	0	50	0	0	0	0	0	0	0	0	NG
			F	0	0	0	0	0	0	0	0	0	0	0	0	NG
			Total	20	50	0	50	0	0	0	0	0	0	0	0	NG
Deserted Ck.	1978	Glova and McCart, 1979	M	16	0	0	56.3	0	18.8	12.5	12.5	0	0	0	0	NG
			F	5	0	0	0	0	80.0	0	20.0	0	0	0	0	NG
			Total	21	0	0	42.9	0	33.3	9.5	14.3	0	0	0	0	NG
Nitinat R.	1979	McCart et al, 1980	M	82	56.1	0	3.7	0	28.1	0	12.2	0	0	0	0	NG
			F	95	0	0	0	2.1	50.5	0	47.4	0	0	0	0	NG
			Total	177	26.0	0	1.7	1.1	40.1	0	31.1	0	0	0	0	NG
Little Qualicum R.	1978	Lister, 1979	M	5	40.0	0	40.0	0	20.0	0	0	0	0	0	0	0/5
			F	4	0	0	0	0	100	0	0	0	0	0	0	1/4
			Total	9	25.0	0	25.0	0	50.0	0	0	0	0	0	0	1/9
FRASER R., N.B.C. and YUKON																
Holmes R.	1981	Rosberg and Aitken, 1982	M	4	0	0	0	0	0	0	0	75	0	25	0	0/4
			F	8	0	0	0	0	0	0	0	100	0	0	0	3/8
			Total	12	0	0	0	0	0	0	0	88.9	0	11.1	0	3/12
Torpy R.	1981	Rosberg and Aitken, 1982	M	15	0	0	0	0	0	26.7	0	66.7	0	6.7	0	0/15
			F	22	0	0	0	0	0	4.5	0	95.5	0	0	0	0/22
			Total	37	0	0	0	0	0	13.5	0	83.8	0	2.7	0	0/37
West Torpy R.	1981	Rosberg and Aitken, 1982	M	7	0	0	0	0	0	0	0	83.3	0	16.7	0	1/7
			F	10	0	0	0	0	0	0	0	80.0	0	20.0	0	0/10
			Total	17	0	0	0	0	0	0	0	81.3	0	18.8	0	1/17
Walker Ck.	1981	Rosberg and Aitken, 1982	M	31	0	0	0	0	0	45.5	0	50.0	0	4.5	0	9/31
			F	32	0	0	0	0	0	13.8	0	75.9	0	10.3	0	3/32
			Total	63	0	0	0	0	0	27.5	0	64.7	0	7.8	0	12/63

NG - not given
* - not readable
NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF CHINOOK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)											
					2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_2	6_3	NR*
FRASER R., N.B.C. and YUKON - Cont'd																
Silm Ck.	1980	Murray et al, 1981	M	28	0	0	0	0	3.6	42.8	3.6	50.0	0	0	0	NG
			F	82	0	0	0	0	9.8	7.3	0	82.9	0	0	0	NG
			Total	110	0	0	0	0	8.2	16.4	0.9	74.5	0	0	0	NG
	1981	Rosberg and Aitken, 1982	M	112	0	0	0	1.6	1.6	39.7	0	55.6	0	1.6	0	49/112
			F	145	0	0	0	0	1.0	11.0	0	88.0	0	0	0	45/145
			Total	257	0	0	0	0.6	1.2	22.1	0	75.5	0	0.6	0	94/257
Bowron R.	1980	Murray et al, 1981	M	40	0	0	0	0	0	17.5	0	82.5	0	0	0	NG
			F	96	0	0	0	0	5.2	3.1	0	91.7	0	0	0	NG
			Total	136	0	0	0	0	3.7	7.4	0	89.0	0	0	0	NG
Willow R.	1980	Murray et al, 1981	M	10	0	0	0	10.0	0	40.0	0	40.0	0	10.0	0	NG
			F	57	0	0	0	0	0	14.0	0	86.0	0	0	0	NG
			Total	67	0	0	0	1.5	0	17.9	0	79.1	0	1.5	0	NG
Stuart R.	1980	Hickey and Lister, 1981	M	132	0	0	0	11.4	0	24.2	0	62.9	0	1.5	0	NG
			F	136	0	0	1.5	0	2.2	15.4	0	80.2	0.7	0	0	NG
			Total	268	0	0	0.7	5.6	1.1	19.8	0	71.6	0.4	0.7	0	NG
Nechako R.	1979	Olmsted et al, 1980	M	9	0	0	22.2	0	44.5	11.1	22.2	0	0	0	0	NG
			F	19	0	0	15.8	0	47.5	21.2	5.3	10.5	0	0	0	NG
			Total	28	0	0	17.9	0	46.4	17.9	10.7	7.1	0	0	0	NG
West Road R. (Blackwater R.)	1980	Olmsted et al, 1981	M	12	0	0	0	0	0	87.5	0	12.5	0	0	0	4/12
			F	5	0	0	0	0	0	80.0	0	20.0	0	0	0	0/5
			Total	17	0	0	0	0	0	84.6	0	15.4	0	0	0	4/17
Nazko R.	1980	Olmsted et al, 1981	M	6	0	0	20.0	0	0	80.0	0	0	0	0	0	1/6
			F	4	0	0	0	0	0	33.3	0	66.7	0	0	0	1/4
			Total	10	0	0	12.5	0	0	62.5	0	25.0	0	0	0	2/10
Cottonwood R.	1980	Olmsted et al, 1981	M	4	0	0	0	0	0	100	0	0	0	0	0	1/4
			F	5	0	0	0	0	60.0	0	0	40.0	0	0	0	0/5
			Total	9	0	0	0	0	37.5	37.5	0	25.0	0	0	0	1/9

NG - not given
* - not readable
NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF CHINOOK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)											
					2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_2	6_3	NR*
FRASER R., N.B.C. and YUKON - Cont'd																
Horsefly R.	1979	Olmsted et al, 1980	M	6	0	0	0	0	50.0	16.7	0	33.3	0	0	0	0/6
			F	5	0	0	0	0	100	0	0	0	0	0	0	0/5
			Total	11	0	0	0	0	72.7	9.1	0	18.2	0	0	0	0/11
Horsefly R.	1980	Olmsted et al, 1981	M	26	0	0	0	15.0	5.0	30.0	0	45.0	0	5.0	0	6/26
			F	30	0	0	0	0	0	8.3	4.2	87.5	0	0	0	6/30
			Total	56	0	0	0	6.8	2.3	18.2	2.3	68.2	0	2.3	0	12/56
McKinley Ck.	1980	Olmsted et al, 1981	M	12	0	0	0	0	0	22.2	0	77.8	0	0	0	3/12
			F	6	0	0	0	0	20.0	0	0	80.0	0	0	0	1/6
			Total	18	0	0	0	0	7.1	14.3	0	78.6	0	0	0	4/18
Quesnel R.	1979	Olmsted et al, 1980	M	27	0	0	14.8	0	63.0	3.7	18.5	0	0	0	0	NG
			F	36	0	0	5.6	0	75.0	5.6	5.6	8.3	0	0	0	NG
			Total	63	0	0	9.5	0	69.8	4.8	11.1	4.8	0	0	0	NG
Quesnel R.	1980	Olmsted et al, 1981	M	184	1.8	0	0.6	17.9	2.5	16.6	2.5	47.9	0	6.1	0.6	21/184
			F	196	0	0	0	0	5.1	5.1	1.1	84.3	0	4.5	0	18/196
			Total	380	0.9	0	0.3	10.3	3.8	10.6	1.8	66.9	0	5.3	0.3	39/380
Eagle R.	1981	Whelen and Olmsted, 1982	M	51	0	0	0	8.3	12.5	66.7	0	12.5	0	0	0	27/51
			F	67	0	0	2.1	0	0	60.4	0	37.5	0	0	0	19/67
			Total	118	0	0	1.4	2.8	4.2	62.5	0	29.2	0	0	0	46/118
Salmon R.	1981	Whelen and Olmsted, 1982	M	35	0	0	11.5	34.6	0	46.2	0	7.7	0	0	0	9/35
			F	60	0	0	2.0	4.1	2.0	59.2	0	32.7	0	0	0	11/60
			Total	95	0	0	5.3	14.7	1.3	54.7	0	24.0	0	0	0	20/95
Adams R.	1981	Whelen and Olmsted, 1982	M	43	3.6	3.6	14.3	7.1	35.7	10.7	10.7	14.3	0	0	0	15/43
			F	77	0	0	0	0	56.1	5.3	5.3	33.3	0	0	0	20/77
			Total	120	1.2	1.2	4.7	2.4	49.1	7.1	7.1	27.1	0	0	0	35/120

NG - not given

* - not readable

NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF CHINOOK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)											
					2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_2	6_3	NR*
FRASER R., N.B.C. and YUKON - Cont'd																
South Thompson R.	1981	Whelan and Olmsted, 1982	M	139	0.9	0.9	1.9	1.9	34.6	1.9	19.6	35.5	0	2.8	0	32/139
			F	678	0	0	0.3	0	50.7	3.1	9.3	32.8	0	3.8	0	68/678
			Total	817	0.1	0.1	0.6	0.3	48.3	2.9	10.9	33.3	0	3.6	0	100/817
Finn Ck.	1981	Scott et al, 1982	M	282	0	0	0.5	14.9	2.7	29.9	0	50.2	0.5	1.4	0	61/282
			F	224	0	0	0	0	6.4	14.0	0	72.7	1.7	5.2	0	52/224
			Total	506	0	0	0.3	8.4	4.3	22.9	0	60.1	1.0	3.1	0	113/506
Raft R.	1981	Scott et al, 1982	M	136	0	0	0	35.1	0	46.5	0	16.7	0.9	0.9	0	22/136
			F	92	0	0	1.2	0	2.5	28.4	0	67.9	0	0	0	11/92
			Total	228	0	0	0.5	20.5	1.0	39.0	0	37.9	0.5	0.5	0	33/228
North Thompson R.	1981	Scott et al, 1982	M	193	0	0	0	19.6	2.0	25.5	0	51.0	0	2.0	0	40/193
			F	207	0	0	0.6	0	1.8	17.1	0.6	79.9	0	0	0	43/207
			Total	400	0	0	0.3	9.5	1.9	21.1	0.3	65.9	0	0.9	0	83/400

NG - not given

* - not readable

NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF COHO STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (In years)					
					2_2	3_2	3_3	4_2	4_3	NR*
		NORTH COAST								
Mathers Ck.	1978	Glova et al, 1979	M	56	30.4	57.1	1.8	0	10.7	NG
			F	22	0	68.2	0	0	31.8	NG
			Total	78	21.8	60.3	1.3	0	16.7	NG
	1979	Grant and McCart, 1980	M	6	0	83.3	0	16.7	0	0/6
			F	4	0	66.7	0	33.3	0	1/4
			Total	10	0	77.8	0	22.2	0	1/10
Gamsby R.	1981	Rosberg et al, 1982	Total	6	0	80.0	0	0	20.0	NG
Kemano R.	1979	Murray and Hamilton, 1981	M	18	0	83.3	0	0	16.7	NG
			F	21	0	95.2	0	0	4.8	NG
			Total	39	0	89.7	0	0	10.3	NG
Kwatna R.	1983	Rice, 1984	M	24	4.2	87.5	0	0	8.3	0/42
			F	18	0	88.9	0	0	11.1	0/18
			Total	42	2.4	88.1	0	0	9.5	0/42
		SOUTH COAST								
Kakweiken R.	1981	Slaney and Milko, 1982	M	102	14.7	58.8	2.9	0	23.5	0/102
			F	72	0	58.3	0	0	41.7	0/72
			Total	174	8.6	58.6	1.7	0	31.0	0/174
Mussel Ck.	1981	Fielden and Slaney, 1982	M	2	0	0	0	0	100	1/2
			F	7	0	100	0	0	0	1/7
			Total	9	0	85.7	0	0	14.3	2/9
	1983	Whelen and Morgan, 1984	M	58	1.8	94.7	0	0	3.5	1/58
			F	25	0	100	0	0	0	0/25
			Total	83	1.2	96.3	0		2.4	1/83
Kilnakilni R.	1983	Whelen and Morgan, 1984	M	10	20.0	60.0	0	0	20.0	0/10
			F	3	0	100.0	0	0	0	0/3
			Total	13	15.4	69.2	0	0	15.4	0/13
Ahnuhati R.	1983	Whelen and Morgan, 1984	M	12	9.1	90.9	0	0	0	1/12
			F	2	0	100	0	0	0	0/2
			Total	14	7.7	92.3	0	0	0	1/14

NG - not given
* - not readable
NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF COHO STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)					
					2_2	3_2	3_3	4_2	4_3	NR*
SOUTH COAST - Cont'd										
Sucwoa R.	1978	Glova and McCart, 1979	M	13	0	100	0	0	0	NG
			F	10	0	100	0	0	0	NG
			Total	23	0	100	0	0	0	NG
Canton Ck.	1978	Glova and McCart, 1979	M	8	0	100	0	0	0	NG
			F	5	0	100	0	0	0	NG
			Total	13	0	100	0	0	0	NG
Deserted Ck.	1978	Glova and McCart, 1979	M	2	0	100	0	0	0	NG
			F	3	0	66.7	0	0	33.3	NG
			Total	5	0	80.0	0	0	20.0	NG
Nitinat R.	1979	McCart et al, 1980	M	10	16.7	83.3	0	0	0	4/10
			F	23	0	90.9	0	9.1	0	12/23
			Total	33	5.9	88.2	0	5.9	0	16/33
Little Qualicum R.	1978	Lister, 1979	M	37	0	100	0	0	0	11/37
			F	26	0	100	0	0	0	10/26
			Total	63	0	100	0	0	0	21/63
FRASER R., N.B.C., and YUKON										
Eagle R. (incl. South Pass Ck.)	1982	Whelen et al, 1983	M	74	0	100	0	0	0	3/74
			F	126	0	96.6	0	0	3.4	8/126
			Total	200	0	97.9	0	0	2.1	11/200
Salmon R. (incl. Bolean Ck.)	1982	Whelen et al, 1983	M	47	0	100	0	0	0	5/47
			F	31	0	100	0	0	0	3/31
			Total	78	0	100	0	0	0	8/78
Adams R. (lower) (incl. Nikwikwla, Hiuihill and Sinmax Cks.)	1982	Whelen et al, 1983	M	13	0	90.9	0	0	9.1	2/13
			F	12	0	100.0	0	0	0	2/12
			Total	25	0	95.2	0	0	4.8	4/25
Adams R. (upper) (incl. Cayenne Ck. and Momich R.)	1982	Whelen et al, 1983	M	10	0	100	0	0	0	0/10
			F	8	0	100	0	0	0	0/8
			Total	18	0	100	0	0	0	0/18
Coldwater R.	1982	Whelen et al, 1983	M	11	0	81.8	0	0	18.2	0/11
			F	9	0	100	0	0	0	0/9
			Total	20	0	90.0	0	0	10.0	0/20

NG - not given
* - not readable
NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF COHO STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)					
					2_2	3_2	3_3	4_2	4_3	NR*
FRASER R., N.B.C., and YUKON - Cont'd										
Albrede R.	1982	Hutton et al, 1983	M	8	0	87.5	0	0	12.5	0/8
			F	9	0	62.5	0	0	37.5	1/9
			Total	17	0	75.0	0	0	25.0	1/17
Lion Ck.	1982	Hutton et al, 1983	M	47	0	91.1	0	0	8.9	2/47
			F	104	0	94.0	0	0	6.0	4/104
			Total	151	0	93.1	0	0	6.9	6/151
Wire Cache Ck.	1982	Hutton et al, 1983	M	6	0	100	0	0	0	0/6
			F	4	0	100	0	0	0	0/4
			Total	10	0	100	0	0	0	0/10
Lemieux Ck.	1982	Hutton et al, 1983	M	29	0	96.2	0	0	3.8	3/29
			F	65	0	98.3	0	0	1.7	7/65
			Total	94	0	97.6	0	0	2.4	10/94
Barriere R.	1982	Hutton et al, 1983	M	7	0	100	0	0	0	0/7
			F	21	0	100	0	0	0	3/21
			Total	28	0	100	0	0	0	3/28
Louis Ck. (incl. Christian Ck.)	1982	Hutton et al, 1983	M	34	0	93.8	0	0	6.3	2/34
			F	36	0	96.8	0	0	3.2	5/36
			Total	70	0	95.2	0	0	4.8	7/70

NG - not given
* - not readable
NOTE: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF CHUM STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)					
					2	3	4	5	6	NR*
		NORTH COAST								
Mathers Ck.	1978	Glova et al, 1979	M	170	0	7.6	76.5	15.9	0	NG
			F	119	0	5.9	73.9	20.2	0	NG
			Total	289	0	6.9	75.4	17.6	0	NG
	1979	Grant and McCart, 1980	M	7	0	40.0	40.0	20.0	0	2/7
			F	3	0	50.0	50.0	0	0	1/3
			Total	10	0	42.9	42.9	14.3	0	3/10
Kitlope R.[1]	1981	Rosberg et al, 1982	M	49	0	4.1	93.9	2.0	0	0/49
			F	30	0	6.7	93.3	0	0	0/30
			Total	79	0	5.1	93.7	1.3	0	0/79
Kemano R.	1979	Murray and Hamilton, 1981	M	206	0	67.5	23.3	9.2	0	NG
			F	261	0	69.7	19.9	10.4	0	NG
			Total	467	0	68.7	21.4	9.9	0	NG
Kwatna R.	1983	Rice, 1984	M	138	0	6.5	63.0	30.4	0	0/138
			F	106	0	7.5	71.7	20.8	0	0/106
			Total	244	0	7.0	66.8	26.2	0	0/244
Quatiena R.	1983	Rice, 1984	M	9	0	44.4	44.4	11.2	0	0/9
			F	12	0	16.7	25.0	58.3	0	0/12
			Total	21	0	28.6	33.3	38.1	0	0/21
		SOUTH COAST								
Kakweiken R.	1981	Slaney and Milko, 1982	M	20	0	25.0	75.0	0	0	0/20
			F	19	0	47.4	52.6	0	0	0/19
			Total	39	0	35.9	64.1	0	0	0/39
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	M	8	0	37.5	50.0	12.5	0	0/8
			F	12	0	33.3	50.0	16.7	0	0/12
			Total	20	0	35.0	50.0	15.0	0	0/20
	1983	Whelen and Morgan, 1984	M	19	0	5.6	38.9	55.6	0	1/19
			F	5	0	0	40.0	60.0	0	0/5
			Total	24	0	4.3	39.1	56.5	0	1/24

NG - not given
* - not readable
[1] - Kitlope R. fish were aged by scale and otilith, elsewhere stocks were aged by scale analysis only

AGE COMPOSITION OF CHUM STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	SEX	N	AGE (in years)					
					2	3	4	5	6	NR*
		SOUTH COAST - Cont'd								
Mussel Ck.	1983	Whelen and Morgan, 1984	M	12	0	9.1	72.7	18.2	0	1/12
			F	2	0	0	50.0	50.0	0	0/2
			Total	14	0	7.7	69.2	23.1	0	1/14
Ahnuhati R.	1981	Fielden and Slaney, 1982	M	6	0	83.3	16.7	0	0	0/6
			F	9	0	77.8	22.2	0	0	0/9
			Total	15	0	80.0	20.0	0	0	0/15
	1983	Whelen and Morgan, 1984	M	58	0	5.4	57.1	37.5	0	2/58
			F	40	0	0	62.2	37.8	0	3/40
			Total	98	0	3.2	59.1	37.6	0	5/98
Sucwoa R.	1978	Glova and McCart, 1979	M	153	0	3.9	92.8	3.3	0	NG
			F	88	0	3.4	94.3	2.3	0	NG
			Total	241	0	3.7	93.4	2.9	0	NG
Canton Ck.	1978	Glova and McCart, 1979	M	88	0	3.4	95.5	1.1	0	NG
			F	82	0	0	100	0	0	NG
			Total	170	0	1.8	97.6	0.6	0	NG
Conuma R.	1978	Glova and McCart, 1979	M	178	0	2.8	96.1	1.1	0	NG
			F	114	0	4.4	92.1	3.5	0	NG
			Total	292	0	3.4	94.5	2.1	0	NG
Tlupana R.	1978	Glova and McCart, 1979	M	33	0	0	100	0	0	NG
			F	44	0	0	97.7	2.3	0	NG
			Total	77	0	0	98.7	1.3	0	NG
Deserted Ck.	1978	Glova and McCart, 1979	M	412	0.5	17.2	78.6	3.6	0	NG
			F	218	0	15.1	82.1	2.8	0	NG
			Total	630	0.3	16.5	79.8	3.3	0	NG
Nitinat R.	1979	McCart et al, 1980	M	41	0	56.1	31.7	7.3	4.9	NG
			F	64	0	51.6	37.5	7.8	3.1	NG
			Total	105	0	53.3	35.2	7.6	3.8	NG
Little Qualicum R.	1978	Lister, 1979	M	204	0	13.4	84.6	2.0	0	3/204
			F	201	0	7.7	91.3	1.0	0	6/201
			Total	405	0	10.6	87.9	1.5	0	9/405

NG - not given
* - not readable
Note: unless otherwise indicated, ages were derived from scale analysis

AGE COMPOSITION OF SOCKEYE STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	METHODS	SEX	N	AGE (in years)								
						3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_3	NR*
			NORTH COAST											
Kitlope R.	1981	Rosberg et al, 1982	Scale, Otolith Analysis	M	7	14.3	0	0	0	0	71.4	0	14.3	0/7
				F	7	14.3	0	14.3	14.3	0	57.1	0	0	0/7
				Total	14	14.3	0	7.1	7.1	0	64.3	0	7.1	0/14
Tezwa R.	1981	Rosberg et al, 1982	Scale, Otolith Analysis	M	7	0	0	0	42.9	0	42.9	0	14.3	NG
				F	3	0	0	0	66.7	0	33.3	0	0	NG
				Total	10	0	0	0	50.0	0	40.0	0	10.0	NG
Kaiitan Ck.	1981	Rosberg et al, 1982	Scale, Otolith Analysis	M	36	0	0	0	69.4	2.8	11.1	8.3	8.3	NG
				F	35	0	0	0	5.7	0	74.3	0	20.0	NG
				Total	71	0	0	0	38.0	1.4	42.3	4.2	14.1	NG
Kwatna R.	1983	Rice, 1984	scale analysis	M	7	0	14.2	0	42.9	0	42.9	0	0	0/7
				F	5	0	0	0	60.0	0	40.0	0	0	0/5
				Total	12	0	8.3	0	50.0	0	41.7	0	0	0/12
			SOUTH COAST											
Kakweiken R.	1981	Slaney and Milko, 1982	Scale Analysis	M	36	0	0	0	33.3	2.8	36.1	22.2	5.6	**
				F	25	0	0	0	52.0	0	24.0	20.0	4.0	**
				Total	61	0	0	0	41.0	1.6	31.1	21.3	4.9	NG
Mussel Ck.	1983	Whelen and Morgan, 1984	Scale Analysis	M	5	0	0	0	40.0	0	40.0	20.0	0	0/5
				F	2	0	0	0	50.0	0	0	50.0	0	0/2
				Total	7	0	0	0	42.9	0	28.6	28.6	0	0/7
Sucwoa R.	1978	Glova and McCart, 1979	Scale Analysis	M	54	0	9.3	0	75.9	0	11.1	3.7	0	NG
				F	25	0	0	0	56.0	0	36.0	8.0	0	NG
				Total	79	0	6.3	0	69.6	0	19.0	5.1	0	NG
Canton Ck.	1978	Glova and McCart, 1979	Scale Analysis	M	4	0	0	0	75	0	25	0	0	NG
				F	5	0	0	0	100	0	0	0	0	NG
				Total	9	0	0	0	88.9	0	11.1	0	0	NG
			FRASER R., N.B.C., and YUKON											
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Scale Analysis	M	51	0	65.8	0	34.2	0	0	0	0	13/51
				F	19	0	23.1	0	76.9	0	0	0	0	6/19
				Total	70	0	54.9	0	45.1	0	0	0	0	19/70
Raft R.	1981	Scott et al, 1982	Scale Analysis	M	41	0	15.4	0	57.7	0	26.9	0	0	15/41
				F	11	0	0	0	66.7	0	33.3	0	0	2/11
				Total	52	0	11.4	0	60.0	0	28.6	0	0	17/52

NG - not given
* - not readable
** - the report gives totals of 7% (males) and 14% (females) but does not include these in sample totals

AGE COMPOSITION OF PINK STOCKS SAMPLED (expressed as %)

STREAM	YEAR	SOURCE	METHODS	SEX	N	AGE (in years)	
						2	NR*
			NORTH COAST				
Quatna R.	1983	Rice, 1984	All pinks were assumed to be aged 2				
Quatlena R.	1983	Rice, 1984					
Nootum R.	1983	Rice, 1984					
			SOUTH COAST				
Glendale/ Tom Browne Cks.	1983	Whelen and Morgan, 1984	Scale Analysis	M F Total	5 9 14	100 100 100	0/5 0/9 0/14
Ahnuhati R.	1983	Whelen and Morgan, 1984	Scale Analysis	M F Total	6 9 15	100 100 100	0/6 0/9 0/15
			FRASER R., N.B.C. and YUKON				
Adams R.	1981	Whelen and Olmsted, 1982	Scale Analysis	M F Total	3 5 8	100 100 100	NG NG NG
South Thompson R.	1981	Whelen and Olmsted, 1982	Scale Analysis	M F Total	12 21 33	100 100 100	NG NG NG
North Thompson R.	1981	Scott et al, 1982	Scale Analysis	Total	6	100	NG

NG - not given
* - not readable

APPENDIX C-6

LENGTH AT AGE of Stocks Sampled

Similar to the age data, all the length data have been recalculated. The source report appendices were considered to be the primary authority, and baseline length data was organized to conform to the age classifications described in APPENDIX C-5. Some data for badly decomposed fish were rejected. In general, fork length (FL) was measured on live fish to avoid their injury, and postorbital-hypural length (POHL) was measured on carcasses: regressions were calculated and used for conversion where necessary. Sex was always recorded along with length.

In addition, regression equations were rejected if they were derived from a limited amount of data; new equations were developed from the largest possible data set within the source document appendices (these are noted on the tables). All equations were standardized to convert FL to POHL. Conversions to POHL used the equations developed for this study. Each equation and its applications given in the tables.

In the recalculated FL-POHL regression equations the value of "a" has been calculated to two decimal places, while the value of "b" was calculated to three decimal places. In a test using a small sample size (n=9) the FL value derived from an equation where "a" was accurate to zero decimal places and "b" was accurate to one decimal place was found to be 3.3% higher than the calculated mean. The equation with the greater accuracy (ie, two and three decimal places, respectively), deviated from the calculated mean by less than 0.1%.

LENGTH (mm) OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)													
							2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	NR	$\overline{x}$ FOHL
NORTH COAST																				
Morice R.	1978	Smith and Berezay, 1983	Carcass Recovery	-	M	25	369±37	-	557±65	331	790±114	570±32	889±62	738±38	-	-	-	-	571±77	607±60
				-	F	46	-	-	-	-	713±19	708±70	804±32	704±21	-	-	671	-	759±37	732±16
				-	Total	71	369±37	-	557±65	331	723±23	608±48	823±36	711±19	-	-	671	-	711±19	688±27
	1979	Smith and Berezay, 1983	Carcass Recovery	-	M	157	-	-	596±74	517±114	748±47	562±21	817±15	761±18	-	-	834±19	-	666±71	698±21
				-	F	151	-	-	564	-	731±17	663±99	782±15	721±10	-	-	786±15	-	738±35	740±9
				-	Total	308	-	-	592±64	517±114	739±24	572±23	794±13	738±10	-	-	804±14	-	698±44	719±12
	1980	Smith and Berezay, 1983	Carcass Recovery	-	M	85	-	-	-	379	771	674±95	-	782±22	-	-	844±49	805	776±43	776±22
				-	F	182	-	-	-	331±34	710±44	627±64	856±52	732±11	-	-	803±38	812	689±44	720±14
				-	Total	267	-	-	-	347±38	718±41	637±55	856±52	746±11	-	-	818±31	809±7	732±33	738±12
Kitlope R.	1981	Rosberg et al, 1982	Carcass Recovery, Seining	FOHL=55.58 + 0.709xFL r = 0.997[3]	M	23	-	-	-	380	680	560±58	880	791±15	-	-	881±31	-	-	733±74[6]
				FOHL=189.39+0.610xFL r = 0.98[4] x	F	18	-	-	-	-	-	-	-	787±38	-	-	799±60	-	-	764±33[7]
				FOHL=71.10 + 0.705xFL r = 0.99	Total	41	-	-	-	380	680	560±58	880	789±22	-	-	844±38	-	-	746±44
SOUTH COAST																				
Mussel Ck.	1981	Fielden and Slaney, 1982	Carcass Recovery	-	M	16	-	-	-	640±40	-	655	-	753±5	-	-	-	-	495±55	493±64[1]
				-	F	10	-	-	-	-	-	-	750	727±69	-	-	580	-	643±65	720±41[2]
				-	Total	26	-	-	-	640±40	-	655	750	733±52	-	-	580	-	520±57	521±57
	1983	Whelen and Morgan, 1984	Angling, Counting Fence	-	M	102	350	-	493±55	382±19	649±89	542±20	550	695±45	-	-	-	-	559±63	530±25
				-	F	107	-	-	-	-	607±95	597±86	730±19	707±14	-	-	723±44	-	726±20	706±29
				-	Total	209	350	-	493±55	382±19	633±64	548±20	720±26	709±14	-	-	723±14	-	643±44	620±18
Ahnuhati R.	1983	Whelen and Morgan, 1984	Angling, Carcass Recovery	-	M	11	-	-	-	385	650	468±85	-	773±47	500	-	880	-	630±220	630±102
				-	F	12	-	-	-	-	-	-	-	754±39	-	-	-	-	740±20	792±32
				-	Total	23	-	-	-	385	650	468±85	-	762±28	500	-	880	-	685±110	715±61
Sucwoa R.*[5]	1978	Glova and McCart, 1979	Carcass Recovery	-	M	29	372±	-	476±	-	766±	-	804±	-	-	-	-	-	NG	540±44
				-	F	13	448±	-	621±	-	708	-	754±	-	-	-	-	-	NG	780±24
				FOHL=71.10 + 0.705xFL	Total	42	382±	-	489±	-	730±	-	773±	-	-	-	-	-	NG	591±

* Age - Specific Data for Fork Lengths only.
** overall FOHL values include unaged fish.
NG - Not Given.

[1] N=23
[2] N=12
[3] N=10
[4] N=4
[5] FOHL calculated from Kitlope River Regression.
[6] N=88
[7] N=37

LENGTH (mm) OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.)													
							2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	NR	$\overline{x}$ POHL
							SOUTH COAST - Cont'd													
Canton Ck.*[5]	1978	Glova and McCart, 1979	Carcass Recovery	-	M	20	380±	-	414±	-	-	-	-	-	-	-	-	-	NG	461±99[6]
				-	F	0	-	-	-	-	-	-	-	-	-	-	-	-	NG	803±66[7]
				POHL=71.10+0.705xFL	Total	20	380±	-	414±	-	-	-	-	-	-	-	-	-	NG	529±
Conuma R.*[5]	1978	Glova and McCart, 1979	Carcass Recovery	-	M	0	-	-	-	-	-	-	-	-	-	-	-	-	-	579±54[8]
				-	F	0	-	-	-	-	-	-	-	-	-	-	-	-	-	778±18[9]
				-	Total	0	-	-	-	-	-	-	-	-	-	-	-	-	-	657±
Tlupana R.*[5]	1978	Glova and McCart, 1979	Carcass Recovery	-	M	0	-	-	-	-	-	-	-	-	-	-	-	-	-	688±103[10]
				-	F	0	-	-	-	-	-	-	-	-	-	-	-	-	-	730±59[11]
				-	Total	0	-	-	-	-	-	-	-	-	-	-	-	-	-	709±
Deserted Ck.*[5]	1978	Glova and McCart, 1979	Carcass Recovery	-	M	16	-	-	474±	-	729±	651±	829±	-	-	-	-	-	NG	513±54[12]
				-	F	5	-	-	-	-	682±	-	741±	-	-	-	-	-	NG	748±24[13]
				POHL=71.10+0.705xFL	Total	21	-	-	474±	-	702±	651±	800±	-	-	-	-	-	NG	619±
Nitinat R.**	1979	McCart et al, 1980	Carcass Recovery	-	M	82	373±10	-	508±12	-	716±30	-	843±31	-	-	-	-	-	-	566±
				-	F	95	-	-	-	597±53	750±11	-	798±10	-	-	-	-	-	-	784±
				-	Total	177	373±10	-	508±12	597±53	739±-	-	806±-	-	-	-	-	-	-	683±
Little Qualicum R.	1978	Lister, 1979	Carcass Recovery	-	M	5	363±65	-	608±155	-	780	-	-	-	-	-	-	-	-	544±170
				-	F	4	-	-	-	-	760±45	-	-	-	-	-	-	-	760	760±32
				-	Total	9	363±65	-	608±155	-	765±33	-	-	-	-	-	-	-	760	640±118
							FRASER R., N.B.C. and YUKON													
Holmes R.	1981	Rosberg and Aitken, 1982	Carcass Recovery	POHL=351.43+0.485xFL r = 0.98[1]	M	4	-	-	-	-	-	-	-	882±22	-	-	845	-	-	873±24
				POHL=86.75+0.927xFL r = 0.96[2]	F	8	-	-	-	-	-	-	-	727±43	-	-	-	-	680±106	709±46
				POHL=42.40+0.774xFL r = 0.98	Total	12	-	-	-	-	-	-	-	789±63	-	-	845	-	680±106	764±56
Torpy R. (Incl. West Torpy R.)	1981	Rosberg and Aitken, 1982	Carcass Recovery	POHL=23.43+0.790xFL r = 0.95[3]	M	22	-	-	-	-	-	566±31	-	770±38	-	-	850	-	-	731±48
				POHL=19.48+0.806xFL r = 0.96[4]	F	59	-	-	-	-	-	545	-	720±16	-	-	800	-	-	731±23
				POHL=33.13+0.786xFL r = 0.95	Total	81	-	-	-	-	-	562±25	-	737±18	-	-	833±33	-	-	731±21

* Age - Specific Data for Fork Lengths only.
** $\overline{X}$ overall POHL values include unaged fish.
NG - Not Given.

[1] N=3
[2] N=8
[3] N=22
[4] N=33
[5] POHL calculated from Kitlope River Regression.
[6] N=13
[7] N=3
[8] N=54
[9] N=35
[10] N=3
[11] N=3
[12] N=39
[13] N=30

LENGTH (mm) OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.)													
							2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	NR	$\overline{x}$ POHL
FRASER R., N.B.C. and YUKON - Cont'd																				
Walker Ck.	1981	Rosberg and Aitken, 1982	Carcass Recovery	POHL=19,61+0,775xFL r = 0,99[17]	M	31	-	-	-	-	-	565±15	-	757±27	-	-	900	-	682±53	679±36[15]
				POHL=31,78+0,867xFL r = 0,95[18]	F	32	-	-	-	-	-	596±11	-	724±15	-	-	809±57	-	733±52	713±23[16]
				POHL=15,67+0,796xFL r = 0,96	Total	63	-	-	-	-	-	574±15	-	733±14	-	-	829±62	-	695±43	696±21
Silm Ck.	1980	Murray et al, 1981	Carcass Recovery, Live Sacrifice	FL=2,61 + 1,20xPOHL	M	43	-	-	-	-	665	498±60	715	722±12	-	-	-	-	643±60	634±38[1]
				FL=13,12 + 1,02xPOHL	F	115	-	-	-	-	689±32	601±47	-	692±8	-	-	-	-	659±35	677±9[2]
				POHL=13,85+0,801xFL r = 0,96[3]	Total	158	-	-	-	-	687±29	539±47	715	698±8	-	-	-	-	653±31	666±13
	1981	Rosberg and Aitken, 1982	Carcass Recovery	POHL=19,38+0,770xFL r = 0,99[19]	M	116	-	-	-	305	810	571±24	-	739±18	-	-	840	-	636±24	644±20[19]
				POHL=16,42+0,792xFL r = 0,91[20]	F	145	-	-	-	-	765	607±22	-	714±8	-	-	-	-	695±16	700±8[20]
				POHL=10,61+0,791xFL r = 0,97	Total	261	-	-	-	305	788±45	583±19	-	721±8	-	-	840	-	664±16	679±11
Bowron R.	1980	Murray et al, 1981	Carcass Recovery, Live Sacrifice	FL=1,37 + 1,26xPOHL	M	58	-	-	-	-	705	548±50	-	729±18	-	-	-	-	737±35	711±20[4]
				FL=12,84 +1,04xPOHL	F	132	-	-	-	-	721±47	595±13	-	707±7	-	-	-	-	683±18	701±7[5]
				POHL=369,96+0,386xFL[6] r = 0,63	Total	190	-	-	-	-	719±41	567±33	-	713±7	-	-	-	-	703±20	704±8
Willow R. (Incl. Wansa Ck.)	1980	Murray et al, 1981	Carcass Recovery	POHL=96,78+0,681xFL r = 0,98[9]	M	14	-	-	-	385	-	631±42	-	733±27	-	-	830	-	648±144	685±54[7]
				POHL=0,57+0,844xFL r = 0,90[10]	F	68	-	-	-	-	-	653±13	-	706±11	-	-	-	-	664±26	688±11[8]
				POHL=137,32+0,656xFL r = 0,95	Total	82	-	-	-	385	-	645±16	-	708±11	-	-	830	-	660±40	688±14
Stuart R.	1980	Hickey and Lister, 1981	Carcass Recovery	POHL=19,48+0,776xFL r = 0,99[11]	M	154	-	-	-	377±30	-	620±22	-	767±8	-	-	843±55	-	720±54	689±21[13]
				POHL=3,50+0,818xFL r = 0,96[12]	F	152	-	-	630±40	-	793±7	632±17	715	727±8	595	-	-	-	704±21	707±8[14]
				POHL=36,16+0,769xFL r = 0,98	Total	306	-	-	630±40	377±30	793±7	625±15	715	744±6	595	-	843±55	-	713±31	698±11
Nechako R.	1979	Olmsted et al, 1980	Angling, Carcass Recovery	-	M	0*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				POHL=63,88+0,684xFL	F	20	-	-	585±22	-	667±17	708±80	679	659±41	-	-	-	-	611	642±19
				-	Total	20	-	-	585±22	-	667±17	708±80	679	659±41	-	-	-	-	611	642±19
West Road (Blackwater R.)	1980	Olmsted et al, 1981	Angling	POHL=-38,69+0,835xFL r = 0,98	M	12	-	-	-	-	-	546±31	-	715	-	-	-	-	671±48	592±41
				POHL=136,99+0,637xFL r = 0,99	F	5	-	-	-	-	-	598±16	-	670	-	-	-	-	-	612±31
				POHL=-2,67+0,796xFL r = 0,96	Total	17	-	-	-	-	-	565±25	-	693±45	-	-	-	-	671±48	598±30

* POHL was not determined from male samples.

[1] N=45 (includes unaged fish)
[2] N=125 (includes unaged fish)
[3] N=163
[4] N=60
[5] N=136
[6] N=195
[7] N=21 (includes unaged fish)
[8] N=76 (includes unaged fish)
[9] N=16
[10] N=17
[11] N=30 (includes jacks which were not included in original calculation)
[12] N=35
[13] N=172
[14] N=175
[15] N=32 (includes unaged fish)
[16] N=33 (includes unaged fish)
[17] N=28
[18] N=28
[19] N=123 (includes unaged fish)
[20] N=152 (includes unaged fish)

LENGTH (mm) OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.)													
							2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	NR	$\overline{x}$ POHL
FRASER R., N.B.C. and YUKON - Cont'd																				
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Angling, Carcass Recovery	POHL=39,73+0,729xFL r = 0,99	M	45	310	380	504±43	355±10	691±19	588±69	757±52	650±95	-	-	-	-	648±58	624±39
				POHL=95,90+0,704xFL r = 0,88	F	78	-	-	-	-	700±13	607±112	733±57	694±8	-	-	-	-	692±32	695±10
				POHL=40,40+0,754xFL r = 0,96[1]	Total	123	310	380	504±43	355±10	698±11	598±59	749±36	689±16	-	-	-	-	670±35	669±17
South Thompson R.	1981	Whelen and Olmsted, 1982	Carcass Recovery	POHL=28,75+0,745xFL r = 0,92[2]	M	135	300	330	590	380±200	677±13	600±100	785±20	704±17	-	-	830±20	-	654±27	688±16
				POHL=45,13+0,754xFL r = 0,89[2]	F	672	-	-	570±20	-	694±4	666±18	749±12	697±6	-	-	747±17	-	696±11	700±3
				POHL=81,74+0,706xFL r = 0,95[2]	Total	807	300	330	580±14	380±200	692±4	659±20	759±11	698±5	-	-	756±18	-	684±12	698±4
Finn Ck.	1981	Scott et al, 1982	Angling, Fence, Carcass Recovery	POHL=19,49+0,777xFL r = 0,97[2]	M	325	-	-	550	344±11	728±20	594±13	-	717±8	610	-	823±52	-	613±44	636±14[5]
				POHL=4,63+0,819xFL r = 0,91[2]	F	256	-	-	-	-	712±27	605±13	-	700±7	648±83	-	807±32	-	662±21	688±7[3]
				POHL=42,54+0,765xFL r = 0,94[4]	Total	581	-	-	550	344±11	718±21	601±11	-	707±5	640±66	-	810±23	-	635±27	661±8[6]
Raft R.	1981	Scott et al, 1982	Fence, Carcass Recovery	POHL=11,85+0,779xFL r = 0,98[9]	M	184	-	-	-	336±9	-	595±7	-	716±26	630	-	850	-	588±35	546±20[7]
				POHL=-32,39+0,849xFL r = 0,98[10]	F	106	-	-	620	-	715±10	596±16	-	704±9	-	-	-	-	669±26	671±11[8]
				POHL=0,06+0,801xFL r = 0,98	Total	290	-	-	620	336±9	715±10	595±7	-	707±10	630	-	850	-	607±27	595±15
North Thompson R.	1981	Scott et al, 1982	Seining, Carcass Recovery	POHL=5,87+0,770xFL r = 0,995[11]	M	195	-	-	-	331±8	778±75	597±13	-	764±12	-	-	840±60	-	617±51	625±24[13]
				POHL=17,52+0,790xFL r = 0,97[12]	F	202	-	-	615	-	750	626±12	770	729±7	-	-	825	-	689±21	707±8[14]
				POHL=8,35+0,785xFL r = 0,99	Total	397	-	-	615	331±8	767±44	606±10	770	743±7	-	-	835±35	-	659±27	666±13

[1] N=123
[2] N=100
[3] N=329 (Includes unaged females)
[4] N=200
[5] N=360 (Includes unaged females)
[6] N=689 (Includes unaged fish)
[7] N=204 (Includes unaged fish)
[8] N=131 (Includes unaged fish)
[9] N=56
[10] N=29
[11] N=47
[12] N=40
[13] N=218
[14] N=215

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)													
							2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	5_3	6_1	6_2	6_3	NR	$\bar{x}$ FOHL
FRASER R., N.B.C. and YUKON - Cont'd																				
Nazko R.	1980	Olmsted et al, 1981	Angling	FOHL=16,71+0,760xFL r = 0,995	M	6	-	-	375	-	-	603±100	-	-	-	-	-	-	720	584±116
				FOHL=-49,34+0,866xFL r = 0,99	F	4	-	-	-	-	-	520	-	713±5	-	-	-	-	685	658±93
				FOHL=0,22+0,792xFL r = 0,99	Total	10	-	-	375	-	-	586±93	-	713±95	-	-	-	-	703±35	614±79
Cottonwood R.	1980	Olmsted et al, 1981	Angling, Carcass Recovery	-	M	4	-	-	-	-	-	593±154	-	-	-	-	-	-	795	644±148
				-	F	5	-	-	-	-	687±26	-	-	730±100	-	-	-	-	-	704±41
				-	Total	9	-	-	-	-	687±26	593±154	-	730±100	-	-	-	-	795	677±68
Horsefly R.	1979	Olmsted et al, 1980	Angling, Carcass Recovery	FOHL=-126,64+0,866xFL r = 1,00[9]	M	6	-	-	-	-	671±78	542	-	751±21	-	-	-	-	-	654±76[7]
				FOHL=584,10+1,455xFL r = 1,00[10]	F	5	-	-	-	-	681±36	-	-	-	-	-	-	-	-	673±43[8]
				FOHL=-183,36+0,967xFL r = 0,94	Total	11	-	-	-	-	677±33	542	-	751±21	-	-	-	-	-	666±39
	1980	Olmsted et al, 1981	Angling, Carcass Recovery	FOHL=25,16+0,742xFL r = 0,98[3]	M	27	-	-	-	350±6	640	597±48	-	723±33	-	-	850	-	628±62	639±50
				FOHL=-52,05+0,858xFL r = 0,95[4]	F	26	-	-	-	-	-	665±0	-	715±18	-	-	-	-	682±95	708±18
				FOHL=20,90+0,754xFL r = 0,98	Total	53	-	-	-	350±6	640	616±41	-	718±16	-	-	850	-	646±52	670±29
McKinley R.	1980	Olmsted et al, 1981	Angling, Carcass Recovery	FOHL=91,82+0,668xFL r = 0,98[5]	M	11	-	-	-	-	-	643±195	-	726±23	-	-	-	-	660±180	683±49
				FOHL=-54,34+0,867xFL r = 0,94[6]	F	7	-	-	-	-	775	-	-	685±18	-	-	-	-	735	718±34
				FOHL=91,57+0,677xFL r = 0,96	Total	18	-	-	-	-	775	643±195	-	711±20	-	-	-	-	685±115	697±33
Quesnel R.	1979	Olmsted et al, 1980	Angling, Carcass Recovery	-	M	0*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				FOHL=17,77+,766xFL	F	37	-	-	677±42	-	690±14	637±8	731±42	661±49	-	-	-	-	672	686±12
				-	Total	37	-	-	677±42	-	690±14	637±8	731±42	661±49	-	-	-	-	672	686±12
	1980	Olmsted et al, 1981	Angling, Carcass Recovery	FOHL=13,99+0,756xFL r = 0,996[13]	M	185	305±10	-	593±5	343±13	733±12	553±34	779±42	751±12	-	-	836±27	800	625±73	630±26[11]
				FOHL=92,51+0,697xFL r = 0,88[13]	F	196	-	-	-	-	729±34	619±22	798±25	730±6	-	-	790±26	-	714±20	726±6[12]
				FOHL=15,82+0,766xFL r = 0,99	Total	381	305±10	-	593±5	343±13	730±21	566±29	773±31	736±6	-	-	814±21	800	669±40	680±14
Engle R.	1981	Whelan and Olmsted, 1982	Angling, Carcass Recovery	-	M	51	-	-	-	340	700±53	548±18	-	679±37	-	-	-	-	589±27	579±25
				-	F	67	-	-	630	-	-	579±16	-	670±17	-	-	-	-	614±26	617±14
				FOHL=26,12+0,749xFL r = 0,95[1]	Total	118	-	-	630	340	700±53	568±13	-	671±15	-	-	-	-	600±20	598±14
Salmon R.	1981	Whelan and Olmsted, 1982	Angling, Fence, Carcass Recovery	-	M	35	-	-	463±44	394±38	-	519±23	-	603±45	-	-	-	-	528±60	486±29
				-	F	61	-	-	450	430±60	680	544±14	-	635±21	-	-	-	-	593±37	574±17
				FOHL=-3,49+0,795xFL r = 0,96[2]	Total	95	-	-	460±32	400±33	680	537±13	-	632±19	-	-	-	-	559±36	540±17

* FOHL was not taken from sampled males.

[1] N=122
[2] N=97
[3] N=25
[4] N=8
[5] N=11
[6] N=4
[7] N=14
[8] N=24
[9] N=14 ┐the authors of the source report provided regression equations - however these were
[10] N=24 ┘not presented as they utilized only a minor portion of the available FOHL:FL data.
[11] N=194 (includes unaged fish)
[12] N=210 (includes unaged fish)
[13] N=160
[14] N=107

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.)								
							2_1	2_2	3_1	3_2	4_1	4_2	4_3	NR	$\bar{x}$ POHL
NORTH COAST															
Mathers Ck.	1978	Glova et al, 1979			M	57	321±	-	-	534±	-	-	524±	NG	465±
					F	21	-	-	-	554±	-	-	559±	NG	554±
					Total	78	321±	-	-	540±	-	-	538±	NG	489±
	1979	Grant & McCart, 1980	Carcass Recovery	-	M	6	-	-	-	554±32	-	-	591	-	560±29
				-	F	4	-	-	-	543±26	-	-	570	598	564±38
				-	Total	10	-	-	-	551±23	-	-	581±21	598	562±20
Note: Mathers Ck. (1978) info. in FL only (see Glova et al, 1979) - can include if POHL:FL Regression eqns. avail.															
Gamsby R.*	1981	Rosberg et al, 1982	Carcass Recovery	-	M	4	-	-	-	-	-	-	-	-	579±39
				-	F	2	-	-	-	-	-	-	-	-	543±55
				-	Total	6	-	-	-	-	-	-	-	-	567±
Kwatna R.	1983	Rice, 1984	Angled	FL = 81.8 + 1.15 × POHL r = 0.94[1]	M	23	-	290	-	530±27	-	-	550±40	0/24	520±29[2]
				FL = 1.4 × POHL-68 r = 0.97[1]	F	17	-	-	-	524±20	-	-	529±10	0/17	535±15[3]
				POHL=29.56+0.748×FL r = 0.95[4]	Total	40	-	290	-	527±18	-	-	538±22	0/41	527±17[4]
Note: Kwatna River Regression (POHL - 29.56+0.748×FL) used to convert FL lengths (given in report) to POHL. r = 0.95															
* - 1 Male 3_3 in sample - length = 290 mm (This is included in overall totals)															
SOUTH COAST															
Kakweiken R.*	1981	Slaney and Milko, 1982	Fishway	-	M	0	-	-	-	-	-	-	-	-	-
				-	F	9									576±22
				-	Total	9									576±22
Mussel Ck.	1981	Fielden and Slaney, 1982	Carcass Recovery, Gillnet	-	M	2	-	-	-	-	-	-	590	480	535±110
				-	F	7	-	-	-	554±67	-	-	-	460	540±63
				-	Total	9	-	-	-	554±67	-	-	590	470±20	539±51
	1983	Whelen and Morgan, 1984	Angling, Fence	-	M	58	-	350	-	485±17	-	-	583±15	470	487±18
				-	F	25	-	-	-	483±19	-	-	-	-	483±19
				-	Total	83	-	350	-	485±13	-	-	583±15	470	486±14
Klinaklini R.	1983	Whelen and Morgan, 1984	Angling, Carcass Recovery	-	M	10	-	340±50	-	483±80	-	-	560	-	469±59
				-	F	3	-	-	-	498±118	-	-	-	-	498±118
				-	Total	13	-	340±50	-	488±62	-	-	560	-	476±56
Ahnuhati R.	1983	Whelen and Morgan, 1984	Angling	-	M	12	-	270	-	527±49	-	-	-	530	509±59
				-	F	2	-	-	-	528±25	-	-	-	-	528±25
				-	Total	14	-	270	-	327±41	-	-	-	530	509±51
Conuma R.	1978	Glova & McCart, 1979	Carcass Recovery	-	M	8	-	-	-	495±81	-	-	-	-	495±81
				-	F	2	-	-	-	537±49	-	-	-	-	537±49
				-	Total	10	-	-	-	503±	-	-	-	-	503±
Deserted Ck.	1978	Glova & McCart, 1979	Carcass Recovery	-	M	3	-	-	-	527±93	-	-	-	-	527±93
				-	F	3	-	-	-	547±67	-	-	-	-	547±67
				-	Total	6	-	-	-	537±	-	-	-	-	537±
Nitinat R.	1979	McCart et al, 1980	Carcass Recovery	-	M	10	-	329	-	559±44	-	-	-	NG	470±75
				-	F	23	-	-	-	573±24	-	611	-	NG	570±15
				-	Total	33	-	329	-	567±	-	611	-	NG	540±

* Age-specific data not given in report or appendices.
NG - not given.

[1] Includes fish not sampled for age (total n = 29 (Male), 27 (Female)).
[2] N=29 (includes fish not aged)
[3] N=27 (includes fish not aged)
[4] N=58

LENGTH (mm) OF COHO STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)								
							2_1	2_2	3_1	3_2	4_1	4_2	4_3	NR	$\bar{X}$ FOHL
SOUTH COAST - Cont'd															
Little Qualicum R.	1978	Lister, 1979	Carcass Recovery	-	M	37	-	-	-	488±24	-	-	-	476±32	484±19
				-	F	26	-	-	-	477±20	-	-	-	484±56	479±24
				-	Total	63	-	-	-	484±17	-	-	-	480±31	482±15
FRASER R., N.B.C. and YUKON															
Eagle R. (Incl. South Pass Ck.)	1982	Whelen et al, 1983	Angling, Carcass Recovery	-	M	74	-	-	-	504±10	-	-	-	492±22	504±10
				-	F	126	-	-	-	500±7	-	-	509±31	481±27	499±7
				-	Total	200	-	-	-	502±6	-	-	509±31	485±20	501±6
Salmon R. (Incl. Bolean Ck.)	1982	Whelen et al, 1983	Angling, Carcass Recovery	-	M	47	-	-	-	435±16	-	-	-	459±34	438±15
				-	F	31	-	-	-	456±16	-	-	-	477±57	458±15
				-	Total	78	-	-	-	444±12	-	-	-	466±28	445±11
Adams R. (lower) (Incl. Sinmax, Hinihill and Nikwikwaia Cks.)	1982	Whelen et al, 1983	Angling, Carcass Recovery	-	M	13	-	-	-	469±47	-	-	430	328±25	444±37
				-	F	12	-	-	-	478±22	-	-	-	478±35	478±19
				-	Total	25	-	-	-	473±25	-	-	430	403±88	460±26
Adams R. (upper) (Incl. Momich R. and Cayenne Ck.)	1982	Whelen et al, 1983	Angling, Carcass Recovery	-	M	10	-	-	-	437±32	-	-	-	-	437±32
				-	F	8	-	-	-	449±33	-	-	-	-	449±33
				-	Total	18	-	-	-	442±22	-	-	-	-	442±22
Albreda R.	1982	Hutton, et al 1983	Carcass Recovery	-	M	8	-	-	-	504±42	-	-	567	-	512±44
				-	F	9	-	-	-	514±35	-	-	504±49	500	509±24
				-	Total	17	-	-	-	508±30	-	-	520±47	500	510±23
Lion Ck.	1982	Hutton et al, 1983	Carcass Recovery	-	M	45	-	-	-	468±19	-	-	493±30	428±111	469±17
				-	F	106	-	-	-	476±8	-	-	509±20	477±26	477±8
				-	Total	151	-	-	-	473±8	-	-	501±16	461±39	475±7
Wire Cache Ck.	1982	Hutton et al, 1983	Carcass Recovery	-	M	6	-	-	-	412±52	-	-	-	-	412±52
				-	F	4	-	-	-	-	-	-	-	-	427±30
				-	Total	10	-	-	-	412±52	-	-	-	-	418±32
Lemieux Ck.	1982	Hutton et al, 1983	Carcass Recovery	-	M	30	-	-	-	432±17	-	-	391	348±33	422±17
				-	F	64	-	-	-	434±10	-	-	380	427±17	435±9
				-	Total	94	-	-	-	434±9	-	-	386±11	403±28	429±9
Barriere R.	1982	Hutton et al, 1983	Carcass Recovery	-	M	7	-	-	-	411±33	-	-	-	-	411±33
				-	F	21	-	-	-	449±20	-	-	-	423±75	445±20
				-	Total	28	-	-	-	438±18	-	-	-	423±75	436±17

LENGTH (mm) OF COHO STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)								
							2_1	2_2	3_1	3_2	4_1	4_2	4_3	NR	$\bar{x}$ FOHL
FRASER., N.B.C. and YUKON - Cont'd															
Louis Ck.	1982	Hutton et al, 1983	Carcass Recovery	-	M	30	-	-	-	401±15	-	-	370	388±82	399±14
				-	F	36	-	-	-	438±16	-	-	420±40	431±25	436±13
				-	Total	70	-	-	-	419±12	-	-	403±41	419±29	418±11
Coldwater R.	1982	Hutton et al, 1983	Angling, Carcass Recovery	-	M	11	-	-	-	452±34	-	-	509±170	-	461±38
				-	F	9	-	-	-	479±34	-	-	-	-	479±23
				-	Total	20	-	-	-	466±21	-	-	509±170	-	470±23

LENGTH (mm) OF CHUM STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)						
							2	3	4	5	6	NR	$\bar{x}$ FOHL
							NORTH COAST						
Mathers Ck.*	1978	Glova et al, 1979	Seining	FOHL= 60,34 + 0,71xFL	M	170	-	535± approx 20	588± approx 7	590± approx 12	-	NG	585±13
				FOHL= 83,62 + 0,69xFL	F	119	-	549± approx 14	569± approx 7	582± approx 15	-	NG	569±11
				-	Total	289	-	approx 542	approx 579	approx 586	-	NG	578±
	1979	Grant & McCart, 1980	Seining	-	M	7	-	474±51	531±117	613	-	539±162	528±57
				-	F	3	-	583	562	-	-	543	563±23
				-	Total	10	-	510±79	541±71	613	540±94	540±94	539±41
Kitlope R.	1981	Rosberg et al, 1982	Seining, Carcass Recovery	FOHL=-32,35 + 0,80xFL r = 0,95^{5}	M	48	-	580	645±14	700	-	NG	644±13^{3}
				FOHL=32,45 to ,773xFL r = 0,96^{6}	F	28	-	565±50	614±18	690	-	NG	615±17^{4}
				FOHL=145,52to,604xFL r = 0,90	Total	76	-	570±31	634±12	695±10	-	NG	632±61
Gamsby R.	1981	Rosberg et al, 1982	Carcass Recovery	-	M	3	-	-	700±163	-	-	NG	700±163^{5}
				-	F	3	-	-	670±23	-	-	NG	644±38^{6}
				-	Total	6	-	-	685±75	-	-	NG	665±61
Kemano R. (incl. tribs.)	1979	Murray and Hamilton, 1981	Carcass Recovery, Gillnetting (Kemano Bay)	FOHL=72,51 + 0,680xFL r = 0,93^{7}	M	212	-	574±5	635±12	673±16	-	602±44	599±7
				FOHL=110,80+0,653xFL r = 0,86^{8}	F	278	-	551±5	591±5	625±12	-	500±154	569±5
				FOHL=134,98+0,610xFL r = 0,89	Total	490	-	560±4	560±4	646±12	-	585±30	582±4
Kwatna R. (incl. tribs.)	1983	Rice, 1984	Carcass Recovery	FOHL=22,64 + 0,745xFL r = 0,93^{9}	M	138	-	588±40	625±10	643±12	-	0/138	632±8^{10}
				FOHL=92,64 + 0,683xFL r = 0,90^{9}	F	103	-	562±42	585±9	591±14	-	0/103	584±7^{11}
				FOHL=121 + 0,632xFL r = 0,92^{4}	Total	241	-	576±27	606±8	626±11	-	0/241	611±6

* lengths calculated from regression equation;
** no scales taken from FOHL - sampled fish.
NG - not given.

[1] N=9 (Includes unaged fish)
[2] N=15 (Includes unaged fish)
[3] N=51 (Includes unged fish)
[4] N=35 (Includes unaged fish)
[5] N=42
[6] N=24
[7] N=258
[8] N=317
[9] sample size: males = 133, females = 80 (ie.: some fish aged were not sampled for both FOHL and FL; as well, not all FOHL/FL sampled fish were sampled for age.
[10] 2N=158 (Includes unaged fish)
[11] 9N=118 (Includes unaged fish)
[12] 4N=213
[13] 5N=8(M), 6(F).

LENGTH (mm) OF CHUM STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.) 2	3	4	5	6	NR	x̄ POHL
NORTH COAST - Cont'd													
Quatlena R.	1983	Rice, 1984	Carcass Recovery	FL=POHL x 1.294-4.26 r = 0.79	M	9	-	574±10	613±6	600	-	0/9	594±14
				FL=142.64+0.984xPOHL r = 0.83	F	12	-	559±14	542±27	586±10	-	0/12	570±14
				FL=POHLx1.396-78.29	Total	21	-	568±12	582±31	588±9	-	0/21	580±11
SOUTH COAST													
Kalamalkan R.**	1981	Slaney and	Fishway	-	M	10	-	-	-	-	-	-	625±12
		Millko, 1982		-	F	7	-	-	-	-	-	-	553±13
				-	Total	17	-	-	-	-	-	-	596±27
Glendale/Tom Browne Cks.	1981	Fielden and	Carcass Recovery	-	M	8	-	517±24	716±128	650	-	-	627±82[1]
		Slaney, 1982		-	F	12	-	581±18	596±25	658±75	-	-	590±22[2]
				-	Total	20	-	554±29	644±63	655±44	-	-	604±33
	1983	Whelan and	Carcass Recovery	-	M	19	-	500	611±23	615±12	-	670	610±17
		Morgan, 1984		-	F	5	-	-	598±21	647±37	-	-	627±31
				-	Total	24	-	500	608±19	622±14	-	670	614±15
Mussel Ck.	1983	Whelan and	Angling	-	M	12	-	520	589±23	593±45	-	595	582±23
		Morgan, 1984		-	F	2	-	-	545	630	-	-	588±85
				-	Total	14	-	520	581±22	609±36	-	595	583±19
Ahnuhati R.	1981	Fielden and	Carcass Recovery	-	M	6	-	603±20	655	-	-	-	590±37[1]
		Slaney, 1982		-	F	9	-	547±14	590±20	-	-	-	577±24[2]
				-	Total	15	-	571±20	612±45	-	-	-	582±20
	1983	Whelan and	Angling, Carcass	-	M	58	-	598±17	624±12	659±16	-	623±35	638±9[3]
		Morgan, 1984	Recovery	-	F	40	-	-	599±14	602±15	-	609±15	598±10[4]
				-	Total	98	-	598±17	614±9	637±15	-	612±16	621±8

* lengths calculated from regression equation;
** no scales taken from POHL - sampled fish.
NG - not given.

[1] N=9 (includes unaged fish)
[2] N=13 (includes unaged fish)
[3] N=39 (includes unaged fish)
[4] N=51 (includes unaged fish)
[5] N=989
[6] N=1465
[7] N=465
[8] N=764
[9] N=2047
[10] N=2862
[11] N=377
[12] N=654
[13] N=1029
[14] N=1247

LENGTH (mm) OF CHUM STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.) 2	3	4	5	6	NR	x̄ POHL
SOUTH COAST - Con't													
Sucwoa R.*	1978	Glova and McCart, 1979	Seining, Carcass Recovery	FL= 81.4 + 1.12xPOHL r = 0.87	M	153	-	584±	618±	626±	-	NG	599±2[5]
				FL= 85.4 + 1.06xPOHL r = 0.88	F	88	-	537±	598±	632±	-	NG	581±2[6]
				-	Total	241	-	568±	611±	628±	-	NG	588±
Canton Ck.*	1978	Glova and McCart, 1979	Seining, Carcass Recovery	FL= 23.6 + 1.26xPOHL r = 0.91	M	88	-	543±	586±	544±	-	NG	594±4[7]
				FL=285.2 + 0.72xPOHL r = 0.72	F	87	-	-	595±	-	-	NG	571±4[8]
				-	Total	170	-	543±	590±	544±	-	NG	580±
Conuma R.*	1978	Glova and McCart, 1979	Seining, Carcass Recovery	FL=260 + 0.84xPOHL r = 0.67	M	178	-	551±	600+	526±	-	NG	597±2[9]
				FL=157.1 + 0.95xPOHL r = 0.68	F	114	-	513±	584±	593±	-	NG	577±1[10]
				-	Total	292	-	532±	594±	571±		NG	585±
Tlupana R.*	1978	Glova and McCart, 1979	Seining, Carcass Recovery	FL=59.4 + 1.18xPOHL	M	33	-	-	574±	-	-	NG	587±4[11]
				FL=90.3 + 1.08xPOHL	F	44	-	-	542±	760±	-	NG	570±3[12]
				-	Total	77	-	-	556±	760±	-	NG	576±
Deserted Ck.*	1978	Glova and McCart, 1979	Seining, Carcass Recovery	FL= 59.4 + 1.18xPOHL r = 0.70	M	412	407±	543±	594±	606±	-	NG	578±3[13]
				FL= 90.3 + 1.08xPOHL r = 0.76	F	218	-	527±	576±	597±	-	NG	566±2[14]
				-	Total	630	407±	538±	588±	603±	-	NG	571±
Nitinat R.	1979	McCart et al, 1980	Carcass Recovery	-	M	41	-	560±15	592±19	619±20	629±24	NG	578±13
				-	F	64	-	539±11	586±13	592±36	618±59	NG	564±10
				-	Total	105	-	548±	588±	602±	624±	NG	569±
Little Qualicum R.	1978	Lister, 1979	Carcass Recovery	-	M	204	-	560±	598±	623±	-	NG	593±
				-	F	201	-	580±	587±	600±	-	NG	584±
				-	Total	405	-	567±	592±	615±	-	NG	589±

* lengths (POHL) calculated from FL

** Deserted Ck. Regression used to calc. POHL from FL data

NG - not given.

[1] N=9 (includes unaged fish)
[2] N=13 (includes unaged fish)
[3] N=39 (includes unaged fish)
[4] N=51 (includes unaged fish)
[5] N=989
[6] N=1465
[7] N=465
[8] N=764
[9] N=2047
[10] N=2862
[11] N=377
[12] N=654
[13] N=1029
[14] N=1247

LENGTH (mm) OF SOCKEYE STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	FOHL:FL REGRESSION	SEX	n	FOHL at Age (± 2 S.E.)									
							3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_3	NR	$\overline{x}$ FOHL
							NORTH COAST									
Kitlope R.	1981	Rosberg et al, 1982	Seining, Carcass Recovery	FOHL=16,12 + 0,754xFL r = 0,95[3]	M	7	400	-	-	-	-	530±23	-	570	-	523±31
				FOHL=38,11 + ,870xFL r = 0,95[4]	F	7	-	-	510	490	-	530±22	-	-	-	514±18[2]
				FOHL=51,30 + 0,717xFL r = 0,91	Total	14	400	-	510	490	-	530±15	-	570	-	518±16
Tazwa R.	1981	Rosberg et al, 1982	Carcass Recovery	FOHL=72,26 + 0,658xFL r = 0,996[5]	M	7	-	-	-	432±35	-	530±20	-	530	-	488±43
				-	F	3	-	-	-	480±20	-	530	-	-	-	497±35
				FOHL=85,78 + 0,64xFL r = 0,97[6]	Total	10	-	-	-	451±31	-	530±14	-	530	-	491±31
Kaltan Ck.	1981	Rosberg et al, 1982	Carcass Recovery	FOHL=-7,44 + 0,778XFL r = 0,99	M	36	-	-	-	397±7	270	541±10	413±48	520±20	-	403±9[7]
				FOHL=-22,36 + 0,854xFL r = 0,78[10]	F	35	-	-	-	463±15	-	501±7	-	486±12	-	476±17
				FOHL=-26,96 + 0,827xFL r = 0,96	Total	71	-	-	-	401±9	270	506±8	418±48	496±14	-	428±9
Kwatna R. (incl. Slouslska Ck.)	1983	Rice, 1984	Angling, Carcass Recovery	FL=1,310 x FOHL-5,60 r = 0,98	M	7	-	290	-	475±45	-	535±14	-	-	0/7	474±69
				FL=1,292 x FOHL-8,68 r = 1,0	F	5	-	-	-	485±72	-	490±21	-	-	0/5	487±49
				FL=5,08 + 1,258xFOHL r = 0,97	Total	12	-	290	-	480±46	-	517±26	-	-	0/12	480±43
Mussel Ck.	1983	Whelan and Morgan, 1984	Angling, Fence	-	M	5	-	-	-	450±15	-	528±35	460	-	NG	486±36
				-	F	2	-	-	-	445	-	-	510	-	NG	478±65
				-	Total	7	-	-	-	454±12	-	528±35	489±50	-	NG	484±29

* lengths calculated from regression equation;
** no scales taken from FOHL - sampled fish.
NG - not given.

[1] N=9 (includes unaged fish)
[2] N=13 (includes unaged fish)
[3] N=39 (includes unaged fish)
[4] N=51 (includes unaged fish)
[5] N=989
[6] N=1465
[7] N=465
[8] N=764
[9] N=2047
[10] N=2862
[11] N=377
[12] N=654
[13] N=1029
[14] N=1247

LENGTH (mm) OF SOCKEYE STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	POHL at Age (± 2 S.E.)									
							3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_3	NR	$\bar{x}$ POHL
SOUTH COAST - Cont'd																
Sucwoa R.*[11]	1978	Glova and	Carcass Recovery	POHL=-5.07 + 0.777xFL r = 0.98	M	54	-	429±	-	485±	-	503±	488±	-	NG	483±
		McCart, 1979		POHL=-2.84 to .818xFL r = 0.94	F	25	-	0	-	468±	-	489±	435±	-	NG	473±
				-	Total	79	-	429±	-	481±	-	495±	462±	-	NG	479±
Canton Ck.*[11]	1978	Glova and	Carcass Recovery	POHL=-5.07 ± 0.777xFL r = 0.98	M	4	—	-	-	508±	-	446±	-	-	NG	492±
		McCart, 1979		POHL=-2.84 + 0.818xFL r = 0.94	F	5	-	-	-	466±	-	-	-	-	NG	466±
				-	Total	9	-	-	-	482±	-	446±	-	-	NG	478±
FRASER R., N.B.C. and YUKON																
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Carcass Recovery	-	M	51	-	361±4	-	433±21	-	-	-	-	NG	approx 386
				-	F	19	-	436±54	-	481±5	-	-	-	-	NG	473±
				-	Total	70	-	369±	-	455±	-	-	-	-	NG	approx 410
Raft R.	1981	Scott et al, 1982	Carcass Recovery	-	M	41	-	328±21	-	491±18	-	529±24	-	-	NG	476±
				-	F	11	-	-	-	463±20	-	501±19	-	-	NG	475±
				-	Total	92	-	328±21	-	483±	-	521±	-	-	NG	476±

* Age-Specific Data for Fork Lengths Only.
NG - Not given.

[1] N=10 (Includes unaged fish)
[2] N=14 (Includes unaged fish)
[3] N=10
[4] N=13
[5] N=7
[6] N=9 (too few female for regression)
[7] N=135 (Includes unaged fish)
[8] N=60 (Includes unaged fish)
[9] N=10
[10] N=6
[11] Regression eqns. developed from total North Coast Data (N=27 (male), 21 (female)

LENGTH (mm) OF PINK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	$\overline{x}$ POHL ± 2 S.E.*
NORTH COAST							
Morice R.	1979	Smith and Berezay, 1983	Carcass Recovery	-	M	28	422±15
				-	F	45	401±7
				-	Total	73	409±8
Kitlope R.	1981	Rosberg et al, 1982	Carcass Recovery	-	M	9	436±26
				-	F	8	439±22
				-	Total	17	438±27
Kwatna R. (incl. tribs.)	1983	Rice, 1984	Seined, Carcass Recovery	$FL=39 + 1.17 \times POHL$ $r = 0.69$	M	899	408±2
				$FL=111 + 0.96 \times POHL$ $r = 0.88$	F	573	413±2
				$POHL=60.22+0.678 \times FL$ $r = 0.89$[1]	Total	1469	409±2
Quatlena R.	1983	Rice, 1984	Carcass Recovery	-	M	23	402±14.6
				-	F	31	400±6.7
				-	Total	54	401±7.2
SOUTH COAST							
Kakweiken R.	1981	Slaney and Milko, 1982	Carcass Recovery	-	M	214	448±5
				-	F	116	430±5
				-	Total	330	442±4
Glendale/Tom Browne Cks.	1981	Fielden and Slaney, 1982	Carcass Recovery	-	M	29	462±15
				-	F	17	440±10
				-	Total	46	454±11
	1983	Whelen and Morgan, 1984	Carcass Recovery	-	M	101	429±6
				-	F	105	418±4
				-	Total	206	423±4
Mussel Ck.	1983	Whelen and Morgan, 1984	Angling, Carcass Recovery	-	M	6	398±14
				-	F	1	410
				-	Total	7	399±12

* All stocks sampled were either found or assumed to be 2 years of age.

[1] N = 273

LENGTH (mm) OF PINK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	POHL:FL REGRESSION	SEX	n	$\overline{x}$ POHL ± 2 S.E.
			SOUTH COAST - Cont'd				
Ahnuhati R.	1983	Whelen and Morgan, 1984	Angling, Carcass Recovery	- - -	M F Total	100 113 213	421±6 414±4 417±4
Sucwoa R.	1978	Glova and McCart, 1979	Carcass Recovery	- - -	M F Total	75 178 253	377±9 378±4 378±
Canton Ck.	1978	Glova and McCart, 1979	Carcass Recovery	- - -	M F Total	9 12 21	364±24 370±19 367±
Conuma R.	1978	Glova and McCart, 1979	Carcass Recovery	- - -	M F Total	19 61 80	380±17 388±13 386±
Deserted Ck.	1978	Glova and McCart, 1979	Carcass Recovery	- - -	M F Total	2 3 5	385±10 350±23 364±
			FRASER R., N.B.C. and YUKON				
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Carcass Recovery	- - -	M F Total	3 5 8	443± 438± 440±
South Thompson R.	1981	Whelen and Olmsted, 1982	Carcass Recovery	- - -	M F Total	12 21 33	454± 444± 448±
North Thompson R.	1981	Scott et al, 1982	Carcass Recovery	-	Total	6	425±
South Thompson	1982	Whelen and Olmsted, 1983	Carcass Recovery	$POHL=-53.17+0.852 \times FL$ $r = 0.97^{1}$ $POHL=70.50+0.684 \times FL$ $r = 0.83^{2}$ $POHL=115.66+0.592 \times FL$ $r = 0.84$	M F Total	7 15 22	463±28 447±16 452±14

Notes to Accompany Length at Age Table

- In the POHL:FL regression eqn. the value of "a" should be accurate to 2 decimal places, while the value of the "b" should be accurate to 3 decimal places, ie.: In a test using a small sample size (n=9), the FL value derived from an eqn. where "a" was accurate to 0 decimal places and b was accurate to 1 decimal place was found to be 3.3% higher than the calculated mean. The eqn. with the greater accuracy, however, deviated from the calculated mean by < 0.1%.

- Correlation Coefficient (r) value should be entered on tables.

APPENDIX C-7

FECUNDITIES of Stocks Sampled

All contractors took few or no samples primarily due to conservation concerns. Regression equations relating POHL and fecundity were calculated for each species and stock except sockeye. Population ("standard") fecundities were calculated using mean POHL data from Appendix C-6 and are compared in the tables with observed mean fecundities.

The large standard errors for observed mean fecundities suggest that basing the fecundity of one stock on the regression relationship developed from another may not provide an accurate estimate of that figure.

FECUNDITIES OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
			NORTH COAST				
Kitlope R.	1981	Rosberg et al, 1982	assumed fecundity based on length similarities with Kitimat R. stocks	-	-	-	8000
			SOUTH COAST				
Mussel Ck.	1983	Whelen and Morgan, 1984	direct count or volumetric assessment - report non-specific	6	6112±1190	Fec.=59.26xPOHL - 37986	3852
Ahnuhati R.	1983	Whelen and Morgan, 1984	direct count or volumetric assessment	1	7000	-	-
Nitinat R.	1979	McCart et al, 1980	direct count	15	4943±585	$\log_{10}$ FEC = 1.327x $\log_{10}$ POHL + 1.193	5047
			FRASER R., N.B.C. and YUKON				
Sila Ck.	1980	Murray et al, 1981	volumetric subsample	8	6557±1042	equation not used	-
	1981	Rosberg & Aitken, 1982	calculated from sub-sample counts	7	6057±1479	equation not used	-
Bowron R.	1980	Murray et al, 1981	volumetric subsample	9	6313±761	equation not used	-
Willow R.	1980	Murray et al, 1981	volumetric subsample	1	6656	-	-
Stuart R.	1980	Hickey & Lister, 1981	volumetric subsample	5	5184±1215	equation not used	-
Nechako R. (incl. tribs.)	1979	Olmsted et al, 1980	direct count	3	5932±1268	Fec.=20.83xPOHL - 7389	5984
West Road (Blackwater) /Nazko R's	1980	Olmsted et al, 1981	$\bar{x}$ lengths substituted into Quesnel R. regression eqn. (developed from pooled 1979 & 1980 data)	-	-	Fec.=12.93xPOHL - 2655	5298 (West Road) 5840 (Nazko)

[1] calculated from regression equation

FECUNDITIES OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
			FRASER R., N.B.C. and YUKON - cont'd				
Cottonwood R.	1980	Olmsted et al, 1981	$\bar{x}$ lengths substituted into Quesnel R. regression eqn. (developed from pooled 1979 and 1980 data)	-	-	Fec.=12.95xPOHL - 2655	6460
Horsefly R.	1979	Olmsted et al, 1980	revised fecundity obtained from Quesnel R. regression presented in Olmsted et al, 1981	-	-	Fec.=12.93xPOHL - 2655	6008
Horsefly R./ McKinley Ck.	1980	Olmsted et al, 1981	$\bar{x}$ length data substituted into Quesnel R. regression eqn. (derived from pooled 1979 & 1980 data)	-	-	Fec.=12.93xPOHL - 2655	6499
Quesnel R.	1979	Olmsted et al, 1980	direct count 1981 readjustment	11 11	6342±496 -	Fec.=37.04xPOHL - 19245 Fec.=12.93xPOHL - 2655	5757 6073
	1980	Olmsted et al, 1981	direct count; equation developed from pooled 1979 & 1980 data	7	6653±468	Fec.=12.93xPOHL - 2655	5250
Eagle R.	1981	Whelen and Olmsted, 1982	$\bar{x}$ overall length substituted into Quesnel R. (1981) equation (Olmsted et al, 1981)	-	-	Fec.=12.93xPOHL - 2655	4750
Salmon R.	1981	Whelen and Olmsted, 1982	as for Eagle R. (1981)	-	-	Fec.=12.93xPOHL - 2655	6280
Adams R. (lower)	1981	Whelen and Olmsted, 1982	as for Eagle R. (1981)	-	-	Fec.=12.93xPOHL - 2655	6390
Finn Ck.	1981	Scott et al, 1982	as for Eagle R. (1981)	2	5321±958	Fec.=12.93xPOHL - 2655	6255
Raft R.	1981	Scott et al, 1982	as for Eagle R. (1981)	3	4856±944	Fec.=12.93xPOHL - 2655	5837
North Thompson R.	1981	Scott et al, 1982	as for Eagle R. (1981)	2	5339±322	Fec.=12.93xPOHL - 2655	6490

[1] calculated from regression equation

FECUNDITIES OF COHO STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
NORTH COAST							
Kwatna R.	1983	Rice, 1984	subsample count (10% of skein by weight)	10	2751±546	$\log_{10}$ Fec=1.64 × $\log_{10}$ POHL - 1.08 r = 0.32	2495
SOUTH COAST							
Kakweiken R.	1981	Slaney and Milko, 1982	direct count	9	3282±411	Fec.=3.85xPOHL + 1060	3273
Mussel Ck.	1981	Fielden and Slaney, 1982	direct count	3	3873±1724	-	-
	1983	Whelen and Morgan, 1984	direct count or volumetric subsample - report non-specific	3	3040±356	-	-
FRASER R., N.B.C. and YUKON							
Eagle R.	1982	Whelen et al, 1983	$\bar{x}$ fecundity derived from equation developed by Beacham (1982)	-	-	Fec.=11.45xPOHL - 2649	3065
Salmon R.	1982	Whelen et al, 1983	as for Eagle R. (1982)	1	3000 (PSM)[2]	Fec.=11.45xPOHL - 2649	2595
Adams R. (lower)	1982	Whelen et al, 1983	as for Eagle R. (1982)	-	-	Fec.=11.45xPOHL - 2649	2824
Adams R. (upper)	1982	Whelen et al, 1983	as for Eagle R. (1982)	-	-	Fec.=11.45xPOHL - 2649	2400
Coldwater R.	1982	Whelen et al, 1983	as for Eagle R. (1982)	-	-	Fec.=11.45xPOHL - 2649	2835

[1] calculated from regression equation

[2] pre-spawning mortality

FECUNDITIES OF CHUM STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
NORTH COAST							
Mathers Ck.	1978	Glova et al, 1979	Direct Count	14	2711±158	logFec.=1.096xlogPOHL + 0.411	2718
Kitlope R.	1981	Rosberg et al, 1982	substitution of 1982 Kitlope R. length data into recently-developed regression eqns. for other coastal streams	-	-	various: see Glova et al, 1979; Glova & McCart, 1979; Lister, 1979; Murray & Hamilton, 1981	3067
Kemano R.	1979	Murray and Hamilton, 1981	Direct Count	8	2847±442	logFec=1.7xlogPOHL + 0.47	2890[3]
Kwatna R.	1983	Rice, 1984	subsample count (10% of skein by weight)	1	3020	-	-
SOUTH COAST							
Ahnuhati R.	1983	Whelen and Morgan, 1984	direct count or volumetric subsample - report non-specific	8	2938±667	Fec=18.86xPOHL - 8471	2675
Sucwoa R. Canton Ck. Conuma R. Tlupana R.	1978	Glova and McCart, 1979	direct egg counts were made; fecundity and POHL data were pooled to develop eqn.	16	overall range = 1896 - 3422	$log_{10}Fec=1.662xlog_{10}POHL - 1.148$	2762 2692 2734 2686
Deserted Ck.	1978	Glova and McCart, 1979	direct count	12	2512[4]	$log_{10}Fec=0.482xlog_{10}POHL + 2.07$	2531
Nitinat R.	1979	McCart et al, 1980	direct count	15	2448±306	$log_{10}Fec=1.987xlog_{10}POHL - 0.072$	2566±
Little Qualicum R.	1978	Lister, 1979	unknown	33	2935±243	Fec=127.8xPOHL - 4414	3076±

[1] calculated from regression equation

[3] The calculated fecundity was deemed unacceptable due to a wide 95% confidence interval

[4] calculated from scatterplot in source document

FECUNDITIES OF SOCKEYE STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
			NORTH COAST				
Kaltan Ck.	1981	Rosberg et al, 1982	estimates derived from comparison with data collected under a separate study in 1981	-	-	not given	4169
Kwatna R.	1983	Rice, 1984	subsample count (10% of skein by weight)	1	5225	-	-
			SOUTH COAST				
Kakweiken R.	1981	Slaney and Miiko, 1982	direct count	2	3177±659	-	-
Ahnuhati R.	1983	Whelen and Morgan, 1984	volumetric subsample	1	2800	-	-

[1] calculated from regression equation

FECUNDITIES OF PINK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	METHODS	N	OBSERVED $\bar{x}$ FECUNDITY (±2 S.E.)	FECUNDITY VS POHL REGRESSION	"STANDARD"[1] FECUNDITY
			NORTH COAST				
Kwatna R.	1983	Rice, 1984	subsample count (10% of skein by weight)	8	1314±171	Fec. 1313 + 1.24 x POHL r = 0.09	1825
			SOUTH COAST				
Kakweiken R.	1981	Slaney and Nilko, 1980	Direct Count	1	1582	-	-
Glendale/Tom Browne Cks.	1983	Whelen and Morgan, 1984	direct count or volumetric subsample - report is non-specific	8	1534±195	Fec.=14.05xPOHL - 4558	1335
Ahnuhati R.	1983	Whelen and Morgan, 1984	direct count or volumetric subsample	9	1822±260	Fec.=14.02xPOHL - 4198	1606

[1] calculated from regression equation

1. The large standard errors of calculated fecundity rates and wide differences in observed fecundity means between stocks suggest that basing the "standard" fecundity of one stock on the FL/POHL regression relationship developed from another may not provide an accurate estimate of that figure. A case in point is the regression equation developed for the Quesnel R. in 1981. This equation was used initially to calculate fecundities for chinook stocks previously studies in the Quesnel, Cottonwood and West Road River watersheds. In 1982 the same equation was utilized in the determination of fecundities for stocks in the North and South Thompson River draingage, which characteristicly had "observed" mean fecundities approx. 20% lower than reported for the Quesnel R. However, the calculated mean fecundities for South and North Thompson tributaries corresonded closely with that calculated for the Quesnel R. This problem is lessened somewhat for other species, which do not exhibit the same degree of variation in $\bar{x}$ fecundity between stocks.

APPENDIX C-8

EGG RETENTION (Percent of Fecundity) Found in Stocks Sampled

Egg retention was estimated to calculate an egg loss factor to derive overall egg deposition for a group of spawners. Egg retention was established by estimating the number of eggs left in the body cavity of moribund females and carcasses, either in terms of actual numbers or as a percent of the assumed fecundity. Egg loss through predation or redd superimposition was not considered at this stage.

There was a large difference in rate of retention between samples with prespawning mortalities (PSM) included and those where PSMs are calculated separately, even though the percentage of PSM is small relative to the sample size. The New Projects studies assumed that the proportion of PSM remained the same throughout the spawning period, although in some cases this assumption may have been incorrect.

EGG RETENTION (% OF FECUNDITY) FOUND IN CHINOOK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. % RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0%	>0-10%	>10-50%	>50-100%
			NORTH COAST						
Morice R.	1978-80	Smith and Berezay, 1983	378	NG	NG	<2.0% of sampled fish unspawned			
Kitlope R.	1981	Rosberg et al, 1982	20	0.29	0-3.0	50	50	0	0
			SOUTH COAST						
Mussel Ck	1981	Fielden and Slaney, 1982	7	NG	NG	57.1	42.9	0	0
	1983	Whelen and Morgan, 1984	6	0.4	0-2.5	80	20	0	0
Ahnuhati R.	1983	Whelen and Morgan, 1984	7	<0.1	0-0.3	71.4	28.6	0	0
Sucwoa R.	1979	Glova and McCart, 1979	26	<1.0	NG	50% of fish sampled retained eggs			
Conuma R.	1978	Glova and McCart, 1979	25	<1.0	NG	16% of fish sampled retained eggs			
Deserted Ck.	1978	Glova and McCart, 1979	11	<5.50	NG	63.6% of fish sampled retained eggs			
Nitinat R.	1979	McCart et al, 1980	422	1.9	0-79.3	47.2	NG	NG	NG
			FRASER R, N.B.C. and YUKON						
Torpy R.*	1981	Rosberg and Aitken, 1982	22	0.88	0-8.4	45.5	54.5	0	0
West Torpy R.*	1981	Rosberg and Aitken, 1982	10	<0.01	0-0.05	90	10	0	0
Walker Ck.*	1981	Rosberg and Aitken, 1982	33	0.45	0-5.6	69.7	30.3	0	0
Slim Ck.	1980	Murray et al, 1981	105	0.15	0-9.15	80	20	0	0
	1981	Rosberg and Aitken, 1982	66[1] 98[2]	5.4 37.41	0-66.0 0-100	43.9 29.6	42.4 28.6	10.6 7.1	3.0 34.4
Bowron R.	1980	Murray et al, 1981	120[1] 123[2]	0.03 2.96	0-0.79 0-100	65.0 63.4	35.0 34.1	0 0	0 2.4

NG - not given
* - data based on an assumed fecundity
1 - not including PSM's
2 - including PSM's

EGG RETENTION (% OF FECUNDITY) FOUND IN CHINOOK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. % RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0%	>0-10%	>10-50%	>50-100%
FRASER R., N.B.C. and YUKON - Cont'd									
Willow R.	1980	Murray et al, 1981	49	0.23	0-7.51	46.9	53.1	0	0
Wansa Ck.	1980	Murray et al, 1981	25	0.37	0-7.51	28.0	72.0	0	0
Stuart R.	1980	Hickey and Lister, 1981	150	1.5	0-100	56.6	39.9	2.0	1.4
Nechako R.	1979	Olmsted et al, 1980	14	21.4	0-100	78.6	0	0	21.4
Horsefly R.	1979	Olmsted et al, 1980	14	0	0	100	0	0	0
	1980	Olmsted et al, 1981	10	0.04	0-0.22	60	40	0	0
Quesnel R.	1979	Olmsted et al, 1980	32	12.57	0-100	84.4	3.1	0	12.5
	1980	Olmsted et al, 1981	61	0.96	0-14.88	31.1	63.9	4.9	0
Eagle R.	1981	Whelen and Olmsted, 1982	48	1.2	0-100	56.3	39.6	0	4.2
Salmon R.	1981	Whelen and Olmsted, 1982	32	9.5	0-63.2	75.0	21.9	3.1	0
Adams R. (lower)	1981	Whelen and Olmsted, 1982	78	1.3	0-18.2	42.3	56.4	1.3	0
South Thompson R.	1981	Whelen and Olmsted, 1982	678	2.8	0-100	22.6	55.5	21.2	0.7
Finn Ck.	1981	Scott et al, 1982	256	17.7	0-100	approx. 63	approx. 26	approx. 5	approx. 6
Raft R.	1981	Scott et al, 1982	110	15.3	0-100	80.0	15.5	1.8	2.7
North Thompson R.	1981	Scott et al, 1982	217	2.2	0-100	48.5	40.1	0.5	0.9

NG - not given

[1] - not including PSM's

[2] - including PSM's

EGG RETENTION ($ OF FECUNDITY) FOUND IN COHO STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. $ RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0$	>0-10$	>10-50$	>50-100$
FRASER R., N.B.C. and YUKON									
Eagle R. (Incl. South Pass Ck.)	1982	Whelen et al, 1983	83	1.25	0-48.9	48.2	44.6	7.2	0
Salmon R. (Incl. Bolean Ck.)	1982	Whelen et al, 1983	10	11.98	0-100	50	20	20	10
Albreda R.	1982	Hutton et al, 1983	9	<2	-	----------- all fish spawned out ---------			
Lion Ck.	1982	Hutton et al, 1983	104	<2	0-100	-------- 98.1 ----		0	1.9
Lemieux Ck.	1982	Hutton et al, 1983	44	2-5	0-50±	----approx. 98----		approx. 1	approx. 1
Barriere R.	1982	Hutton et al, 1983	21	1-4	0-50±	-------- 95.3 ----		--------- 4.7 --------	
Louis Ck. (Incl. Christian Ck.)	1982	Hutton et al, 1983	22	<2	-	----------- all fish spawned out --------			

NG - not given

EGG RETENTION (% OF FECUNDITY) FOUND IN CHUM STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. % RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0%	>0-10%	>10-50%	>50-100%
NORTH COAST									
Mathers Ck.	1978	Glova et al, 1979	135	1.28	0-57.9	37.8	NG	NG	NG
Kitlope R.	1981	Rosberg et al, 1982	11	0.33	0-2.2	72.7	27.3	0	0
Gamsby R.	1981	Rosberg et al, 1982	10	0.36	0.33	60	40	0	0
Kemano R. (incl. tribs.)	1979	Murray and Hamilton, 1981	347	8.6	≤100	NG	NG	NG	2.9
Kwatna R.	1983	Rice, 1984	117	5.2	0-100	55.0	--------41.6----------		3.4
Quatlena R.	1983	Rice, 1984	12	0	0	100	0	0	0
SOUTH COAST									
Glendale/Tom Browne Ck.s	1981*	Fielden and Slaney, 1982	9	0.23	0-1.9	55.6	44.4	0	0
	1983	Whelen and Morgan, 1984	16	10.3	0-50.7	25.0	50.0	12.5	12.5
Ahnuhati R.	1981	Fielden and Slaney, 1982	9	11.5	0-80.0	33.3	55.6	0	11.1
	1983	Whelen and Morgan, 1984	33	14.8	0-100	36.4	48.5	3.0	12.1
Sucwoa R.	1978	Glova and McCart, 1979	867	1.97	NG	44.8	NG	NG	NG
Canton Ck.	1978	Glova and McCart, 1979	665	0.49	NG	61.8	NG	NG	NG
Conuma R.	1978	Glova and McCart, 1979	1952	0.46	NG	62.4	NG	NG	NG
Tlupana R.	1978	Glova and McCart, 1979	528	1.05	NG	66.9	NG	NG	NG
Deserted Ck.	1978	Glova and McCart, 1979	873	1.56	NG	50.6	NG	NG	NG
Nitinat R.	1979	McCart et al, 1980	65	0.69	0-23.4	38.5	-------- 61.5 -------		0
Little Qualicum R.	1978	Lister, 1979	201	1.5	0-100	91.0			

NG - not given

* - results based on fecundity of approx. 2700 eggs per - female estimated by the authors for Ahnuhati R. chum in 1983

EGG RETENTION ($ OF FECUNDITY) FOUND IN SOCKEYE STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. $ RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0$	>0-10$	>10-50$	>50-100$
NORTH COAST									
Kalitan Ck.	1981	Rosberg et al, 1982	34	0.5	0-7.2	47.1	44.1	8.8	0
SOUTH COAST									
Sucwoa R.	1978	Glova and McCart, 1979	12	approx. 7	NG	50.0	NG	NG	NG

NG - not given

EGG RETENTION (% OF FECUNDITY) FOUND IN PINK STOCKS SAMPLED

STREAM	YEAR	DATA SOURCE	N	AVG. % RETENTION	RANGE OF RETENTION	PERCENT OF SAMPLES RETAINING EGGS			
						0%	>0-10%	>10-50%	>50-100%
NORTH COAST									
Kitlope R.	1981	Rosberg et al, 1982	10	approx. 5	0-100	60	30	0	10
Kwatna R.	1983	Rice, 1984	343	1.8	0-100	67.9	22.2	7.6	2.3
SOUTH COAST									
Kakweiken R.	1981	Slaney and Milko, 1982	111	43.6	0-100	64.2	0	0.9	34.9
Glendale/Tom Browne Cks.*	1983	Whelen and Morgan, 1984	98	12.5	0-100	41.8	22.4	26.5	9.2
Ahnuhati R.*	1983	Whelen and Morgan, 1984	54	0.4	0-12.3	56.7	34.4	8.9	0
Sucwoa R.	1978	Glova and McCart, 1979	57	<0.2	NG	45.6	NG	NG	NG
Canton Ck.	1978	Glova and McCart, 1979	8	<0.1	NG	37.5	NG	NG	NG
Conuma R.	1978	Glova and McCart, 1979	20	<0.1	NG	25	NG	NG	NG

NG - not given

* - values shown differ from those presented in source report

Notes to Accompany Egg Retention Table

1. As can be seen from selected entries (eg: Bowron R., 1980) there is a large difference in rate of retention between samples with PSM's (pre-spawning mortalities) included and those where PSM's are separate, even though the percentage of PSM's is small, relative to the sample size. This is an important point, and one which may not be taken seriously enough in some studies, when estimations of total egg deposition are attempted. It can not be assumed that the proportion of PSM's in a population will remain the same throughout the spawning period. Only from a continuous sampling effort which includes PSMs and other <100% spawned fish can an accurate estimate of total (actual) egg deposition be made.

APPENDIX C-9

FLESH COLOUR OF CHINOOK STOCKS Sampled

Adult chinook flesh colour was determined in most of the studies by examination of the gill isthmus when the fish was alive, and by examination of the flesh during sampling of fresh carcasses. It should be noted that flesh colour is a highly judgemental factor when applied to deteriorating fish, as it is known that flesh colour pales as sexual maturity progresses.

FLESH COLOR OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	SEX	N	% WHITE	% RED
SOUTH COAST							
Mussel Ck.	1983	Whelen and Morgan, 1984	Isthmus flesh color[1]	M	102	45.1	54.9
				F	107	50.5	49.5
Klinaklini R.	1983	Whelen and Morgan, 1984	Isthmus flesh color[1]	M	0	-	-
				F	3	100	0
Ahnuhati R.	1983	Whelen and Morgan, 1984	Isthmus flesh color[1]	M	11	72.7	27.3
				F	12	91.7	8.3
FRASER R., N.B.C. and YUKON							
Holmes R.	1981	Rosberg and Aitken, 1982	location (from body) unknown[2]	M&F	9	100	0
Torpy R.	1981	Rosberg and Aitken, 1982	location (from body) unknown[2]	M&F	38	94.7	5.3
West Torpy R.	1981	Rosberg and Aitken, 1982	location (from body) unknown[2]	M&F	17	100	0
Walker Ck.	1981	Rosberg and Aitken, 1982	location (from body) unknown[2]	M&F	65	95.4	4.6
Slim Ck.	1981	Rosberg and Aitken, 1982	location (from body) unknown[2]	M	7	71.4	28.6
Nechako R.	1979	Olmsted et al, 1980	location (from body) unknown[1]	M	7	71.4	28.6
				F	15	93.3	6.7
Blackwater R.	1980	Olmsted et al, 1981	Isthmus flesh color[1]	M	12	0	100
				F	5	0	100
Nazko R.	1980	Olmsted et al, 1981	Isthmus flesh color[1]	M	6	0	100
				F	4	25	75
Cottonwood R.	1980	Olmsted et al, 1981	Isthmus flesh color[1]	M	4	25	75
				F	3	0	100

[1] Angled fish
[2] Carcass

FLESH COLOR OF CHINOOK STOCKS SAMPLED

STREAM	YEAR	SOURCE	METHODS	SEX	N	% WHITE	% RED
FRASER R., N.B.C. and YUKON - Cont'd							
Horsefly R.	1979	Olmsted et al, 1980	location (from body) unknown[1]	M	3	0	100
				F	0	-	-
McKinley Ck.	1980	Olmsted et al, 1981	Isthmus flesh color[1]	M	11	0	100
				F	4	0	100
Quesnel R.	1979	Olmsted et al, 1980	location (from body) unknown[1]	M	17	17.6	82.4
				F	16	12.5	87.5
	1980	Olmsted et al, 1981	Isthmus flesh color[1]	M	171	31.6	68.4
				F	149	24.2	75.8
Eagle R.	1981	Whelen and Olmsted, 1982	Isthmus flesh color[1],[2]	M	54	11.1	88.9
				F	64	21.9	78.1
Salmon R.	1981	Whelen and Olmsted, 1982	Isthmus flesh color[1],[2]	M	26	3.8	96.2
				F	49	6.1	93.9
Adams R. (lower)	1981	Whelen and Olmsted, 1982	Isthmus flesh color[1],[2]	M	45	13.3	86.7
				F	77	7.8	92.2
South Thompson R.	1981	Whelen and Olmsted, 1982	Isthmus flesh color[2]	M	139	24.0	76.0
				F	678	21.2	78.8
Finn Ck.	1981	Scott et al, 1982	Isthmus flesh color[1],[2]	M	282	26.6	73.4
				F	224	25.4	74.6
Raft R.	1981	Scott et al, 1982	Isthmus flesh color[1],[2]	M	136	19.9	80.1
				F	92	21.7	78.3
North Thompson R.	1981	Scott et al, 1982	Isthmus flesh color[2]	M	193	11.4	88.6
				F	207	9.7	90.3

[1] Angled fish
[2] Carcass

1) Possibly differing methods in determination of flesh color as well as personnel training and efficiency could bias ratios one way or another.

APPENDIX C-10

Results of DISEASE SURVEYS Undertaken

Surveys of the endemic disease characteristics of salmonid populations focussed on those pathogens and parasites known to cause hatchery losses. Diagnostic processes included external and internal examinations for parasites and infected areas, laboratory treatments for bacterial and viral disease agents and histological sectioning of possibly infected tissues. All microorganisms found in the samples are reported, whether or not they were associated with a particular disease. In most cases the DFO Disease Diagnostics Service (DDS) performed the analyses but in one case (Whelen et al. 1983) the E.V.S. Consulting Co. Ltd. disease laboratory was used. The reader is advised that the DDS maintains more complete and current listings of all disease survey results, which can be accessed upon request.

CHINOOK

RESULTS OF DISEASE SURVEYS UNDERTAKEN

STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
				SOUTH COAST			
Mussel Ck.	1981[1]	Fielden and Slaney, 1982	13	*Aeromonas salmonicida*	5	38.5	this is considered to be a high rate of infection
			13	*Salmincola* sp.	-	-	light infections
			13	*Myxidium* sp.	-	-	light infections
	1983	Whelan and Morgan, 1984	29	*A. salmonicida*	17	58.6	this is an unusually high rate of infection
				FRASER R., N.B.C. and YUKON			
Slim Ck.	1980	Murray et al, 1981	24	*Ceratomyxa shasta*	7	29.2	
			24	*Myxidium* sp.	3	12.5	
	1981	Rosberg and Aitken, 1982	55	*C. shasta*	10	18.2	no mortalities documented
Bowron R.	1980	Murray et al, 1981	25	*Henneguya salmonicida*	1	4.0	
			25	*C. shasta*	5	20.0	
			25	*Myxidium* sp.	11	44.0	
			9	*C. shasta*	9	100	
Wansa Ck.	1980	Murray et al, 1981	7	*C. shasta*	7	100	
Nechako R.	1979	Olmsted et al, 1980	17	none documented	0	0	frozen samples were considered not fully suitable for analysis
Horsefly R.	1979	Olmsted et al, 1980	9	*A. salmonicida*	1	11.1	as for Nechako R.
Quesnel R.	1979	Olmsted et al, 1980	14	*C. shasta*	1	7.1	as for Nechako R.
Quesnel R.	1980	Olmsted et al, 1981	60	*A. salmonicida*	11	18.3	present in carrier stage only; no active infections
			60	*C. shasta*	60	100	all lightly infected
			60	*Myxidium* sp.	30	50	
			60	*Dermocystidium* sp.	6	10	
			-	see comments	-	-	gills of several specimens showed numerous, abnormally large necrotic lesions

[1] several partially - decayed specimens were included in the sample.

RESULTS OF DISEASE SURVEYS UNDERTAKEN

CHINOOK

STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
FRASER R., N.B.C. and YUKON - Cont'd							
Salmon R.	1981	Whelen and Olmsted, 1982	20	C. shasta	20	100	
			20	Myxidium sp.	18	90	
			20	Dermocystidium sp.	-	-	found on the gills of an unspecified number of fish
Finn Ck.	1981	Scott et al, 1982	25	A. salmonicida	see comments		10% of the sample were either infected or were carriers
			25	C. shasta	25	100	several heavy infections & 1 PSM attributed to this parasite
			25	Cryptobia sp.	2	8.0	leeches, the vector of this organism, were commonly observed on the samples
COHO							
SOUTH COAST							
Mussel Ck.	1981	Fielden and Slaney, 1982	3	Salmonicola sp.	-	-	light infections only
			3	Myxidium sp.	-	-	light infectins only
FRASER R., N.B.C. and YUKON							
Eagle R.	1982	Whelen et al, 1983	27	Aeromonas hydrophila	4	14.8	
			52	C. shasta	36	69.2	
			25	Anisakis simplex	3	12.0	light larval infections
			25	Piscicola salmositica	1	4.0	
			52	unidentified fungi	19	36.5	present on gills
			25	Diphyllobothriid gen. sp.	2	8.0	light infections
			27	Phocanema decipiens	1	3.7	larval form present
			25	Salmincola californiensis	1	4.0	
Salmon R.	1982	Whelen et al, 1983	27	A. salmonicida	1	3.7	
			27	A. hydrophila	2	7.4	
			27	C. shasta	24	88.9	no associated mortalities
			27	Myxosporida gen. sp.	2	7.4	
			27	S. californiensis	2	7.4	
			27	Fungi gen. sp.	7	25.9	

RESULTS OF DISEASE SURVEYS UNDERTAKEN

COHO

STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
				FRASER R., N.B.C. and YUKON - Cont'd			
Adams R. (lower)	1982	Whelen et al, 1983	12	*C. shasta*	4	33.3	infected fish had enlarged, discolored gall bladders
			12	*Myxosporida* sp.	1	8.3	
			12	*Anisakis simplex*	1	8.3	larval form present
			12	see comments	1	8.3	a small tumor found in the spleen
Coldwater R.	1982	Whelen et al, 1983	15	*A. hydrophila*	1	6.7	
			15	*Pseudomonas flourescens*	1	6.7	
			15	unidentified myxobacteria	1	6.7	
			15	*C. shasta*	10	66.7	
			15	*Myxidium minteri*	1	6.7	
			15	Fungi gen. sp.	1	6.7	
			15	see comments	1	6.7	a large ulcerated area present on the right ventral body surface
Lion Ck.	1982	Hutton et al, 1983	59	*C. shasta*	39	66.1	
			59	*Cryptobia* sp.	-	-	"several" fish affected
			59	*Myxidium* sp.	1	1.7	

CHUM

STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
				NORTH COAST			
Kwatna R.	1983	Rice, 1984	4	*Aeromonas salmonicida*	2	50	the small sample size precluded conclusive findings

CHUM

STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
				SOUTH COAST			
Glendale/Tom Browne Cks.	1983	Whelen and Morgan, 1984	14	*A. salmonicida*	3	21.4	
Mussel Ck.	1981	Fielden and Slaney, 1982	4	*Salmincola* sp.	4	100	light infections
			4	*A. salmonicida*	1	25	light infections

RESULTS OF DISEASE SURVEYS UNDERTAKEN

	STREAM	YEAR	SOURCE	N	DISEASE ORGANISM	# INFECTED	% INFECTED	COMMENTS
					NORTH COAST			
KOKANEE/ SOCKEYE	Kwatna R.	1983	Rice, 1984	1	none found	0	0	as above.
					SOUTH COAST			
	Mussel Ck.	1981	Fielden and Slaney, 1982	3	I.H.N. (infectious Hemotopoietic Necrosis)	1	33.3	sockeye only in sample
				30	A. salmonicida	-	-	unspecified number infected
				30	Salmincola sp.	-	-	unspecified number infected
				30	Philonema sp.	-	-	unspecified number infected
				30	Chloromyxidium sp.	-	-	unspecified number infected
		1983	Whelen and Morgan, 1984	60	Salmincola sp.	60	100	
				60	Philonema sp.	54	90	
					SOUTH COAST			
PINK	Kwatna R.	1983	Rice, 1984	68	Myxidium sp.	57	83.8	
				68	Chloromyxum sp.	2	2.9	
	Glendale/Tom Browne Cks.	1983	Whelen and Morgan, 1984	17	A. salmonicida	2	11.8	
				17	Renibacterium salmonarum	1	5.9	causative agent of B.K.D.
				17	Myxidium sp.	3	17.6	
				17	Parvicapsula sp.	5	29.4	
				17	unclassified microsporidan parasite	4	23.5	
				17	external fungus	-	approx. 25.0	
				17	BKD (Bacterial Kidney Disease)	1	5.9	
	Ahnuhati R.	1983	Whelen and Morgan, 1984	60	A. salmonicida	3	5.0	
				60	Anisakis sp.	-	-	unspecified number infected
				60	Diphyllobothrium sp.	-	-	unspecified number infected
				60	Myxidium sp.	-	-	unspecified number infected
				60	Parvicapsula sp.	-	-	unspecified number infected

APPENDIX C-11

KEY JUVENILE TIMING DATES

Downstream migrants usually were captured in inclined plane traps (IPTs) or fyke nets (FNs). Catches were calibrated for trap efficiency using trap-hours, percent of stream discharge or cross section fished and mark recovery trials. Daily population estimates, daily percentage of the run, date of peak catch and environmental factors were then compiled. Since different capture techniques select for various sizes and stages, it is noted in the tables which capture methods were used.

It was necessary to standardize migration timing statistics and definitions of various juvenile life stages to compare studies. A major challenge was to differentiate between emergent and reared fry. This distinction was particularly difficult to make for chum salmon and the reader is advised to use caution when reviewing juvenile statistics for this species. Juvenile 1+ and 2+ coho and chinook were more clearly defined, usually on the basis of scale readings or size differences.

Not all studies intercepted the peak migration due to late startup, trap washout or low catches. Peak migration was defined as the period of highest catch, or when trapping success was highest. In general, the last small or first large fish sampled (length and weight) indicated the beginning and end of the run, unless abnormally large or pinheaded fish were noted. Secondary peaks were not considered, and some degree of trap avoidance by older juveniles must be assumed. In many cases, where peak timing dates in the source reports were based on changes in weight, length or development indices, there was disagreement between the source report authors and this summary document.

KEY CHINOOK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
NORTH COAST																			
Morice R.	1979	Smith and Berezay, 1983	IP, FN	Apr 11	Apr 26	Apr 24	late June	-	-	-	-	-	-	-	-	-	-	-	a secondary peak in migration occurred April 23.
	1980	Smith and Berezay, 1983	IP, FN	before Apr 6	Apr 17	Apr 14-15	early July	-	-	-	-	-	-	-	-	-	-	-	a secondary peak in migration occurred during mid-late May.
Kitimat R.	1980	Birch et al, 1981	IP	early Apr	Apr 8 or before	Apr 16	late May	June 4	June10	-	Aug 12	early Apr	Apr 16	Apr 10	Aug 12	early Apr	Apr 23	end May	only low numbers of post-emergents caught.
Hirsch Ck.	1980	Birch et al, 1981	FN	early Apr	Apr 11	Apr 13	June 5	June10	July10	-	July11	early Apr	Apr 13	Apr 13	July11	-	-	-	
Cecil Ck.	1980	Birch et al, 1981	FN	May 7	May 12	May 12	May 14	-	-	-	-	-	-	-	-	-	-	-	
Kildala R.	1981	Slaney et al, 1982	IP	early Mar	Apr 2	Apr 9	May 25	June 1	early June	early June	June26	-	-	-	-	early Mar	Apr 28	late July	a secondary peak in emergent migration occurred in late April.
Dala R.	1981	Slaney et al, 1982	IP	Mar 15	Apr 3	Apr 12	June 4	June 8	-	-	July 2	-	-	-	-	Mar 8	May 4	May 11	a secondary peak in emergent migration occurred in late April.
SOUTH COAST																			
Mussel Ck.	1983	Whelen and Morgan, 1984	MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	It is believed that rearing takes place outside Mussel Creek.
Sucwoa R.	1979	Glova and McCart, 1979	IP	before Apr 15	Apr 23	Apr 28	June 5	-	-	-	-	-	-	-	-	-	-	-	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY CHINOOK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
SOUTH COAST - Cont'd																			
Canton Ck.	1979	Glova and McCart, 1979	IP	before Apr 18	Apr 30	Apr 27	June 8	-	-	-	-	-	-	-	-	-	-	-	
Conuma R.	1979	Glova and McCart, 1979	IP	before Apr 14	May 14	May 13	mid June	-	-	-	-	-	-	-	-	-	-	-	
Tlupana R.	1979	Glova and McCart, 1979	IP	before Apr 19	May 1	May 3	June 8	-	-	-	-	-	-	-	-	-	-	-	
Deserted Ck.	1979	Glova and McCart, 1979	IP	before Apr 20	Apr 24	Apr 24	May 14	-	-	-	-	-	-	-	-	-	-	-	
Little Qualicum R.	1979	Lister et al, 1979	FN	-	-	-	-	-	-	-	-	May 18	June14	June12	June22	-	-	-	
FRASER R., N.B.C. AND YUKON																			
Holmes R.	1981	Rosberg et al, 1982	IP	before Apr 5	May 11	approx Apr 6	approx late May?	-	-	-	-	before Apr 5	May 11	May 8	after Aug 7	Apr 10	Apr 27	May 13	
Morkill R.	1981	Rosberg et al, 1982	IP	Apr 16	May 11	-	late May?	-	-	-	-	Apr 16	June17	May 18	July 9	Apr 18	-	May 6	
Torpy R.	1981	Rosberg et al, 1982	IP	Apr 16	May 2	May 3	approx late May	-	-	-	-	Apr 16	May 2	May 3	mid July	Apr 18	May 7	May 22	captures during June and July were likely reared fry.
Slim Ck.	1981	Rosberg et al, 1981	IP	before Apr 4	May 12	May 12	June	approx late June	July 7	mid July	Sept16	before Apr 4	May 12	May 12	Sept16	early Mar?	Apr 7	May 14	the break point between termination of migrant migration and initiation of reared fry migration is vague.
Bowron R.	1980	Murray et al, 1981	IP	before Apr 8	May 17	May 16	late June	late June	July20	July 9	Aug 10	-	-	-	-	Apr 14	May 15	June19	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY CHINOOK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
FRASER R., N.B.C. AND YUKON - Cont'd																			
Willow R.	1980	Murray et al, 1981	IP	Apr 21	-	early June	late June	late June-early July	July14	approx July14	early Aug	Apr 21	June 7	early June	early Aug	Apr 14	late May	June11	
Stuart R.	1980	Lister et al, 1981	FN, FN(M)	early Apr	May 16	mid May	early June	late May	mid June	-	early Sept	early Apr	May 16	May 17	early Sept	mid Apr	mid May	late May	
Nechako R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	-	early mid May 7	-	-	-	-	-	traps were installed well after initiation of migration.
Horsefly R.	1979	Olmsted et al, 1980	IP, FN	May 3	May 25	mid late May	late June	mid June	-	-	mid July	-	-	-	-	-	-	-	
Quesnel R.	1979	Olmsted et al, 1980	IP, FN	-	early June	-	end June - early July	-	July 29	-	mid Aug	-	-	-	-	-	-	-	a secondary peak in emergent migration occurred on June 11.
	1980	Whelen et al, 1981	IP, FN	before Apr 1	Apr 17	May 1	late June	June19	-	-	July21	-	-	-	-	May 8	Mid June?	July28	
Eagle R.	1981	Whelen et al, 1982	IP	before Apr 6	Apr 17-18	Apr 17	mid-late May	early May	-	-	July12	-	-	-	-	-	-	-	
Salmon R.	1981	Whelen et al, 1982	FN, WR	before Apr 3	May 6	May 4	early May	approx early May	-	-	May 20	before Apr 3	May 6	May 5	May 20	-	-	-	although the 1st capture occurred on Apr 9, distance of trap from the spawning area may have resulted in substantial delay.

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY CHINOOK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
								FRASER R., N.B.C. AND YUKON - Cont'd											
Adams R. (lower)	1981	Whelen et al, 1982	IP	before Apr 5	May 1-2	Apr 24	early June	early Apr 7	-	-	June23	-	-	-	-	-	-	-	
South Thompson R.	1981	Whelen et al, 1982	IP	approx Apr 1	May 10	May 3	June 3	mid-late May	-	-	July 4	-	-	-	-	-	-	-	
Blue R.	1981	Scott et al, 1982	IP	before Apr 3	Apr 3-4	Apr 23	June15	mid June	-	-	July13	-	-	-	-	-	-	-	
Finn Ck.	1981	Scott et al, 1982	FN, MT, SN	before Apr 3	Apr 18 19	Apr 17	June21	approx late May	-	-	early July	-	-	-	-	Apr 10	-	Aug 30	
	1982	Stewart et al, 1983	IP	before Apr 22	May 1	-	May 14	-	-	-	July31	-	-	-	-	before Apr 22	Apr 27	May 1	
Lion Ck.	1981	Scott et al, 1982	FN	-	-	-	-	June19	-	-	July13	-	-	-	-	-	-	-	only 4 underyearlings caught
Raft R.	1981	Scott et al, 1982	IP	before Apr 3	Apr20-21	Apr 26	early June	early June	June22	approx June10	July11	-	-	-	-	-	-	-	
	1982	Stewart et al, 1983	IP	before Apr 7	May 16	-	June 2	early June?	approx June10	-	late July-early Aug	-	-	-	-	Apr 13	-	May 4	yearling catch data limited
Clearwater R.	1982	Stewart et al, 1983	IP	before Apr 8	May 22	-	June 2	early June	approx July 20	-	early Aug?	-	-	-	-	Apr 14	-	July 24	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
FRASER R., N.B.C. AND YUKON - Cont'd																			
Joseph Ck. (incl. tribs.)	1982	Stewart et al, 1983	IP	before Apr 10	early May	-	early June	mid July	-	-	approx July20	-	-	-	-	Apr 20	-	-	catches of both 0+ and 1+ fish were limited
Lemelux Ck.	1982	Stewart et al, 1983	IP	before Apr 10	early Apr ?	-	early June	early June	approx June10	-	late July	-	-	-	-	before Apr 10	Apr 10	Apr 28	
Barriere R.	1982	Stewart et al, 1983	IP	before Apr 10	-	-	early June	late June	-	-	mid July	-	-	-	-	Apr 22	-	-	catch data limited
North Thompson R.	1981	Scott et al, 1982	IP, MT, SN	before Apr 3	May 1-2	May 1	late May	mid May	early June	-	July21	-	-	-	-	Apr 12	-	Aug 20	trap located at Little Fort
	1982	Stewart et al, 1983	IP	approx Apr 12	approx May 22	-	early June?	early June	approx July12	-	after early Aug	-	-	-	-	Apr 27	May 15	July22	trap located at Barriere.

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[2] where data do not permit emergent vs. reared fry breakout, this column provides 0+ timing information.

KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
NORTH COAST																			
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	IP	early Apr ?	May 11	May 6	mid late May	-	-	-	-	-	-	-	-	Apr 23	May 5	May 14	
Morice R. (incl. tribs.)	1979	Smith and Berezay, 1983	IP, FN	-	-	-	-	-	-	-	-	early May	June11	-	late June	before May 3	late May-early June	after June 28	varying distances of traps from spawning grounds likely influenced timing results
	1980	Smith and Berezay, 1983	IP	-	-	-	-	June24	July 1	-	July 9	-	-	-	-	before May 14	June27	approx mid July	2+ coho caught likely exhibited similar timing to 1+ fish.
Kitimat R.	1980	Birch et al, 1981	IP	before Apr 8	June10	approx mid June	July18	early July	late July ?	-	after Aug 18	-	-	-	-	before Apr 8	Apr 23	Aug 10	erratic migration pattern and mis-identification of trout as coho render data unreliable.
Hirsch Ck.	1980	Birch et al, 1981	FN	before Apr 6	early June ?	-	early July	late May ?	early July ?	-	mid-late Aug	-	-	-	-	Apr 18	-	July26	there appears to be a large area of overlap between termination of emergent migration and initiation of reared fry migration.
Cecil Ck.	1980	Birch et al, 1981	FN	before Apr 7	June 6	approx June 6	mid July ?	late June ?	-	-	after Aug 19	-	-	-	-	before Apr 7	Apr 16	after Aug 19 ?	the yearling migration was essentially over by mid May.
Kidala R.	1981	Slaney et al, 1982	IP	Mar 21	June4?	approx June 1	Aug 18	late May ?	-	-	-	Mar 21	June 4	June 1	Aug 18	before Mar 8	May 4	July22	no pattern in size increase exists for 0+ fish; difficult to separate emergents & reared fry.

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[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
NORTH COAST - Cont'd																			
Dale R.	1981	Slaney et al, 1982	IP	Mar 8	May 24	May 24	early July ?	late May ?	mid-late June ?	-	Aug 13	-	-	-	-	early Mar	Apr 29	June24	1 smolt was captured on Aug 14
Bish Ck.	1981	Slaney et al, 1982	FN	mid-late Mar	late May	late May ?	late June	late May ?	-	-	-	mid-late Mar	May 29	approx May 29	July21	mid-late Mar	late Mar	June20	limited sampling effort resulted in an uncertain picture of timing.
SOUTH COAST																			
Sucwoa R.	1979	Glova and McCart, 1979	IP	Apr 18	June 4	May 22	after June 9	-	-	-	-	-	-	-	-	before Apr 15	early May	May 12	peaks in migration occurred during major floods; fry do not appear to rear in this system.
Canton Ck.	1979	Glova and McCart, 1979	IP	Apr 21	May 31	May 20	after June10	-	-	-	-	-	-	-	-	before Apr 18	May 3	May 17	
Conuma R.	1979	Glova and McCart, 1979	IP	before Apr 14	June 6	May 25	after June12	-	-	-	-	-	-	-	-	mid-late Apr	May 3	late May	at DFO - operated Fyke Trap caught 0+ fry initially on Mar 20.
Tlupana R.	1979	Glova and McCart, 1979	IP	Apr 24	Apr 28	May 15	after June 3	-	-	-	-	-	-	-	-	Apr 21	May 4	May 17	
Deserted Ck.	1979	Glova and McCart, 1979	IP	before Apr 20	Apr 30	May 2	May 30	-	-	-	-	-	-	-	-	before Apr 23	May 2	May 15	
Little Qualicum R.	1979	Lister et al, 1979	FN	Apr 30	May 24	May 17 ?	mid-late June ?	late May ?	-	-	after June26	Apr 30	May 24	May 17	after June26	Apr 24	May 21	June26	post-yearlings not separated from yearlings.

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KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
SOUTH COAST - Cont'd																			
Glendale Ck.	1983	Shepherd, 1984	IP	Apr 1	Apr 29 -May 4	May 3	after May 30	-	-	-	-	-	-	-	-	Apr 13	May 8	May 15	
Tom Brown Ck.	1983	Shepherd, 1984	IP	Apr 10	May 14	May 1	May 30	after	-	-	-	-	-	-	-	-	-	-	
FRASER R., N.B.C. AND YUKON																			
Horsefly R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	May 19	July 3	-	after July15	-	-	-	apparently no coho yearlings or post-yearlings were caught.
Quesnel R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	May 20	July13	-	mid-late Aug	-	-	-	no indication of coho smolt captures was given.
	1980	Whelen et al, 1981	IP, FN	Apr 13	May 28	late May	late June - early July	late June	mid - late July	-	Aug 3	-	-	-	-	Apr 26	-	May 5	data for 1+ coho is limited.
Eagle R.	1981	Whelen et al, 1982	IP	before Apr 6	Apr 20	approx Apr 18	early June ?	early May ?	June 14-15	-	Aug 11	-	-	-	-	Apr 21	-	May 23	data for coho is limited.
Salmon R.	1981	Whelen et al, 1982	FN, WR	before Apr 3	May 4-5	May 5	May 31	-	-	-	-	-	-	-	-	-	-	-	It appears that all 0+ fish migrated as emergents.
Adams R.	1981	Whelen et al, 1982	IP	before Apr 5	May 3	May 2	early June ?	-	-	-	July 9	-	-	-	-	Apr 9	-	Apr 18	very few 1+ migrants were trapped.
South Thompson R.	1981	Whelen et al, 1982	IP	Apr 27	-	-	May 19	-	-	-	-	-	-	-	-	-	-	-	very few migrants were caught.

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[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
FRASER R., N.B.C. AND YUKON - Cont'd																			
Blue R.	1981	Scott et al, 1982	IP	before Apr 2	Apr 21	May 2	-	early June ?	-	-	-	before Apr 2	Apr 21	May 2	Aug 4	Apr 4	-	June12	recruitment of fish <35 mm in length and <0.35g in weight was continuous throughout the survey.
Finn Ck.	1981	Scott et al, 1982	FN, WR	Apr 28	July 1	June25	July24	-	-	-	-	Apr 28	July 1	June25	Aug 29	Apr 20	-	June 4	with the exception of Aug 29, no fish were caught in that month.
	1982	Stewart et al, 1983	IP, EF	-	-	-	-	-	-	-	-	late May	July17	-	July24	Apr 27	May 1	-	only a small (n=7) number of 1+ fish caught.
Lion Ck.	1981	Scott et al, 1982	FN	before Apr 3	Apr 20-21	mid-May	Aug ?	late May	July 9 ?	-	late Aug or after	before Apr 3	Apr 20-21	May 16	late Aug or after	Apr 11	-	June15	few 1+ fish were captured.
Raft R.	1981	Scott et al, 1982	IP	before Apr 3	approx June 5			Apr 20 ?	June30 ?	-	July 7	before Apr 3	June 29-30	June27	July 7	Apr 26		July 2	few 1+ fish captured.
	1982	Stewart et al, 1983	IP	Apr 16	-	-	July 6 ?	-	-	-	-	Apr 16	June30	late June	end July ?	Apr 30	-	May 4	only 4 1+ coho caught.
Clearwater R.	1982	Stewart et al, 1983	IP	Apr 16	-	-	-	-	-	-	-	-	-	-	-	-	Apr 25		
Joseph Ck. (incl. tribs.)	1982	Stewart et al, 1983	IP, EF	Apr 19	May 11	-	May 25	-	-	-	-	Apr 19	May 11	-	late July	May 11	-	May 19	only 6 1+ coho caught by all methods.
Lemieux Ck.	1982	Stewart et al, 1983	IP, EF	Apr 15	-	-	-	-	-	-	-	-	-	-	-	Apr 15	Apr 24	June16	
Barriere R. (incl North Barriere R)	1982	Stewart et al, 1983	IP	Apr 22	-	-	-	-	-	-	-	-	-	-	-	Apr 23	-	June30	

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[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY COHO JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
FRASER R., N.B.C. AND YUKON - Cont'd																			
North Thompson R.	1981	Scott et al, 1982	IP	Apr 8	May 1	May 1	late July ?	early May ?	-	-	Aug 13	-	-	-	-	Apr 26	-	June 9	very few 1+ coho captured.
	1982	Stewart et al, 1983	IP	Apr 26	-	-	-	-	-	-	-	-	-	-	-	-	May 15		May 15 is the only capture date for 1+ coho.

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KEY CHUM JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
									NORTH COAST										
Mathers Ck.	1979	Northern Natural Resources Services Ltd, 1979	IP	before Apr 14	May 5	approx late Apr-early May	after May 14	-	-	-	-	-	-	-	-	-	-	-	substantial catches were being recorded at project termination.
Kitimat R.	1980	Birch et al, 1981	IP	before Apr 8	before Apr 8	-	early May ?	before Apr 8	-	-	June 2	before Apr 8	before Apr 8	-	June 2	-	-	-	fry which were not positively identified as chum were caught up to July 23
Hirsch Ck.	1980	Birch et al, 1981	FN	before Apr 6	Apr 22 ?	-	-	-	-	-	-	before Apr 6	Apr 22 ?	before Apr 22	May 24	-	-	-	
Kildala R.	1981	Slaney et al, 1982	IP	-	-	-	approx May 20	early Mar ?	-	-	June10	before Mar 8	Mar 25	Mar 26	June10	-	-	-	separation of emergents from reared fry is difficult as emergent recruitment was ongoing throughout much, if not all, of the sampling period.
Dala R.	1981	Slaney et al, 1982	IP	-	-	-	early May ?	before Mar 7?	-	-	May 16	before Mar 7	Mar 26	Mar 26	May 16	-	-	-	
Bish Ck.	1981	Slaney et al, 1982	FN	-	-	-	-	-	-	-	-	before Mar 17	before Mar 17 ?	before Mar 17 ?	May 1	-	-	-	
									SOUTH COAST										
Sucwoa R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before early Apr	May 2	late Apr ?	June 5	-	-	-	start of migration was much later in tributary A of this stream (Apr. 9th).
Canton Ck.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before mid Apr	mid-Apr ?	mid-Apr ?	June 3	-	-	-	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY CHUM JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
SOUTH COAST - Cont'd																			
Conuma R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before early Apr	mid-Apr ?	mid-Apr ?	mid-June	-	-	-	a fyke trap operated by DFO caught chum initially on March 10 (1st day of effort)
Tlupana R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before Apr 19	Apr 23	approx Apr 20 ?	after June 10	-	-	-	
Deserted Ck.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before Apr 19	Apr 25	approx Apr 25	late May	-	-	-	
Little Qualicum R.	1979	Lister et al, 1979	FN	-	-	-	-	June 6 ?	-	-	-	before Apr 24	May 21	mid-May	June 26	-	-	-	
Glendale Ck.	1983	Shepherd, 1984	IP	Apr 1	May 4	Apr 29	May 30	-	-	-	-	-	-	-	-	-	-	-	
Tom Browne Ck.	1983	Shepherd, 1984	IP	Before Mar 31	Apr 11	Apr 14	May 10	-	-	-	-	-	-	-	-	-	-	-	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY SOCKEYE JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
NORTH COAST																			
Mathers Ck.	1979	Northern Natural Resource Services Ltd, 1979	IP	-	-	-	-	-	-	-	-	-	-	-	-	Apr 27	May 5	after May 14	some underyearling migration likely took place.
Morice R.	1979	Smith and Berezay, 1983	IP	-	-	-	-	-	-	-	-	-	-	-	-	before May 15	May 16	June23	
	1980	Smith and Berezay, 1983	IP	-	-	-	-	-	-	-	-	-	-	-	-	before May 13	May 19	June29	
Kitimat R.	1980	Birch et al, 1981	IP									July 4	-	-	July22				
Kildala R.	1981	Slaney et al, 1982	IP	-	-	-	-	-	-	-	-	Apr 3	July 1	June17	July 2	-	-	-	only 16 underyearlings were caught.
Dala R.	1981	Slaney et al, 1982	IP	-	-	-	-	-	-	-	-	before Mar 7	Mar 25 - 26	Apr 8	June 7	-	-	-	
SOUTH COAST																			
Sucwoa R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	mid-Apr	Apr 29	May 3	June 4	-	-	-	
Canton Ck.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	Apr 19	Apr 23	Apr 27	May 21	-	-	-	
Conuma R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before Apr 14	May 4	May 4	June 6	-	-	-	a DFO fyke trap caught low numbers of migrants between Mar 11 and Apr 7.
Tlupana R.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before Apr 19	May 17	May 17	approx mid-June	-	-	-	

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[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY SOCKEYE JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
								SOUTH COAST - Cont'd											
Glendale Ck.	1983	Shepherd, 1984	IP	-	-	-	-	-	-	-	-	-	-	-	-	Apr 19	May 9	after May 30	Presmolts
Glendale Ck.	1983	Shepherd, 1984	IP	-	-	-	-	-	-	-	-	-	-	-	-	Apr 21	May 8	May 30	Smolts
Tom Browne Ck.	1983	Shepherd, 1984	IP	-	-	-	-	-	-	-	-	-	-	-	-	-	Apr 17 29		Presmolts, n=2
Tom Browne Ck.	1983	Shepherd, 1984	IP	-	-	-	-	-	-	-	-	-	-	-	-	-	Apr 13	-	Smolts, n=1
Deserted Ck.	1979	Glova and McCart, 1979	IP	-	-	-	-	-	-	-	-	before Apr 22	Apr 29	Apr 29	May 28	before Apr 23	Apr 24 ?	May 5	
								FRASER R., N.B.C. AND YUKON											
Bowron R.	1980	Murray et al, 1981	IP	-	-	-	-	-	-	-	-	May 14	-	-	May 27	May 15	-	May 16	migrant numbers were very low.
Nechako R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	June 2	-	-	June 4	-	-	-	cnly 9 migrants trapped
Horsefly R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	early Apr ?	May 23	-	June29	-	-	-	
Quesnel R.	1979	Olmsted et al, 1980	IP, FN	-	-	-	-	-	-	-	-	May 9	June22	-	Aug 2	-	-	-	6 smolts (1+) were caught during mid-June.
	1980	Whelen et al, 1981	IP, FN	-	-	-	-	-	-	-	-	Apr 6	May 17	May 11	July28	Apr 19	May 7	July20	timing results are somewhat influenced by the distance between downstream trapping locations.
Eagle R.	1981	Whelen et al, 1982	IP	-	-	-	-	-	-	-	-	Apr 26	May 9	May 9	May 17	-	-	-	although 1+ fish were absent from IPT catches a substantial number were caught by seine.

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[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY SOCKEYE JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
FRASER R., N.B.C. AND YUKON - Cont'd																			
Salmon R.	1981	Whelen et al, 1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	substantial numbers of rearing fry and smolts were captured by seine.
Adams R. (lower)	1981	Whelen et al, 1982	IP	-	-	-	-	-	-	-	-	before Apr 5	May 12	May 10	June16	-	-	-	
South Thompson R.	1981	Whelen et al, 1982	IP	-	-	-	-	-	-	-	-	Apr 29	-	-	July14	-	-	-	
Raft R.	1981	Scott et al, 1982	IP	-	-	-	-	-	-	-	-	Apr 5	Apr 20	Apr 27	June26	-	-	-	
	1982	Stewart et al, 1983	IP	-	-	-	-	-	-	-	-	Apr 30	May 14	-	early June ?		-	-	
Barriere R.	1982	Stewart et al, 1983	IP	-	-	-	-	-	-	-	-	-	-	-	-	-	May 6	-	low numbers of 0+ fish were caught but timing details are not given.
North Thompson R.	1981	Scott et al, 1982	IP	-	-	-	-	-	-	-	-	before Apr 5	May 3	May 4	July21	-	-	-	
	1982	Stewart et al, 1983	IP	-	-	-	-	-	-	-	-	Apr 30 ?	May 22	-	early June ?	-	July	-	Indicated yearling peak may not be indicative of true peak.

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1 IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

2 where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY PINK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
NORTH COAST																			
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	IP	before Apr 14	Apr 29	approx end Apr	after May 14	-	-	-	-	-	-	-	-	-	-	-	
Kitimat R.	1980	Birch et al, 1981	IP	before Apr 8	before Apr 8?	-	May 21	-	-	-	-	-	-	-	-	-	-	-	
Hirsch Ck.	1980	Birch et al, 1981	IP	before Apr 6	Apr 23	Apr 23	May 4	-	-	-	-	-	-	-	-	-	-	-	
Kildala R.	1981	Slaney et al, 1982	IP	before Mar 8	Mar 26	Mar 26 -27	May 6	-	-	-	-	-	-	-	-	-	-	-	
Dala R.	1981	Slaney et al, 1982	IP	before Mar 7	Apr 3	early Apr.	May 4												
Bish Ck.	1981	Slaney et al, 1982	FN	before Mar 17	Mar 26	late Mar ?	May 23	-	-	-	-	-	-	-	-	-	-	-	
SOUTH COAST																			
Sucwoa R.	1979	Glova and McCart, 1979	IP	before Apr 15	Apr 16 ?	-	May 2	-	-	-	-	-	-	-	-	-	-	-	
Canton Ck.	1979	Glova and McCart, 1979	IP	before Apr 18	Apr 22 ?	-	May 14	-	-	-	-	-	-	-	-	-	-	-	
Conuma R.	1979	Glova and McCart, 1979	IP	before Apr 14	Apr 14 ?	-	early June	-	-	-	-	-	-	-	-	-	-	-	a DFO fyke trap initially caught pink fry on March 10.
Tlupana R.	1979	Glova and McCart, 1979	IP	before Apr 19	Apr 20 ?	-	May 6	-	-	-	-	-	-	-	-	-	-	-	

[1] IP - inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

KEY PINK JUVENILE TIMING DATES

STREAM	YEAR	SOURCE	METHODS[1]	EMERGENTS (0+)				REARED FRY (0+)				UNDERYEARLINGS (0+)[2]				YEARLINGS (1+)			COMMENTS
				START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	50%	END	START	PEAK	END	
SOUTH COAST - Cont'd																			
Glendale Ck.	1983	Shepherd, 1984	IP	before Mar 31	Apr 16	Apr 16	May 20	-	-	-	-	-	-	-	-	-	-	-	
Tom Browne Ck.	1983	Shepherd, 1984	IP	before Mar 31	Apr 4 (or prior)	Apr 11	May 15	-	-	-	-	-	-	-	-	-	-	-	
FRASER R., N.B.C. AND YUKON																			
Barriere R.	1982	Stewart et al, 1983	IP	mid-Apr	-	-	May 6	-	-	-	-	-	-	-	-	-	-	-	only small numbers of migrants present.
North Thompson R.	1982	Stewart et al, 1983	IP	Apr 26	-	-	May 22	-	-	-	-	-	-	-	-	-	-	-	

[1] IP - Inclined plane, FN - fyke net, FN(M) - modified fyke net, WR - weir, MT - minnow trap.

[2] where data do not permit emergent vs. reared fry breakout, this column will provide 0+ timing information.

General Notes:

1) In many cases my estimates, where based on changes in weight and/or length and/or developmental indices (K_D), did not reflect the conclusions of the source report Authors. In addition, where a clear picture of timing was not drawn by the authors, there was often a considerable degree of guesswork involved in interpreting appended data.

2) A major and recurring problem has been in differentiating the timings of emergents vs. reared fry, ie: where emergent migration terminates and where reared fry migration begins. Typically, I have looked for the last small or first large samples (lengths/weights) to appear but have approached this cautiously, as abnormally small or large fish may appear at any time during the first several months of migration/rearing, ie: pinheads, diseased fish (which for whatever cause may retain water but may not be gaining weight as growth.

3) Older juveniles are more likely to avoid detection in traditional trapping surveys (ie: IPT, FNT) as they are more able to swim against the current and escape from the mouth/throat of the trap before being swept into the holding box.

APPENDIX C-12

DIEL VARIATION IN JUVENILE MIGRATIONS

Many studies did not address diurnal variation in downstream migration timing, but noted the general proportions of nocturnal and daylight migrations. Four studies that addressed diurnal variation on an hourly basis are described in these tables.

DIEL VARIATION IN JUVENILE CHINOOK MIGRATIONS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	PERCENT OF TOTAL FRY CAPTURED											
				12:00 - 14:00*	14:00 - 16:00*	16:00 - 18:00*	18:00 - 20:00*	20:00 - 22:00*	22:00 - 24:00*	24:00 - 02:00*	02:00 - 04:00*	04:00 - 06:00*	06:00 - 08:00*	08:00 - 10:00*	10:00 - 12:00*
NORTH COAST															
no information															
SOUTH COAST															
Sucwoa R.	1979	Glova and McCart, 1979	0+	0	0	0	approx 1.0	approx 4.5	approx 19.5	approx 12.5	approx 54.0	approx 6.0	approx 3.5	0	0
Canton Ck.	1979	Glova and McCart, 1979	0+	approx 1.0	approx 1.0	0	0	approx 4.5	approx 51.5	approx 27.0	approx 12.0	approx 1.5	approx 1.5	0	0
Conuma R.	1979	Glova and McCart, 1979	0+	approx 1.5	approx 1.5	approx 1.5	0	approx 11.0	approx 42.0	approx 16.5	approx 19.5	approx 4.5	0	approx 1.5	0
Tlupana R.	1979	Glova and McCart, 1979	0+	0	0	0	0	approx 15.0	0	approx 36.5	approx 33.5	approx 15.5	0	0	0
FRASER R., N.B.C. AND YUKON															
Bowron R.	1980	Murray et al, 1981	0+	continued from 1000 hours				6.4		67.7		25.9			

* Pacific Standard Time.

DIEL VARIATION IN JUVENILE CHUM MIGRATIONS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	PERCENT OF TOTAL FRY CAPTURED											
				12:00 - 14:00*	14:00 - 16:00*	16:00 - 18:00*	18:00 - 20:00*	20:00 - 22:00*	22:00 - 24:00*	24:00 - 02:00*	02:00 - 04:00*	04:00 - 06:00*	06:00 - 08:00*	08:00 - 10:00*	10:00 - 12:00*
				NORTH COAST											
Kitimat R.	1980	Birch et al, 1981	0+	- results shown as Diurnal: 5.8%, Nocturnal: 94.2%											
Hirsch Ck.	1980	Birch et al, 1981	0+	- results shown as Diurnal: 1.9%, Nocturnal: 98.1%											
				SOUTH COAST											
Sucwoa R.	1979	Glova and McCart, 1979	0+	approx 1.0	approx 1.0	approx 1.0	approx 2.0	approx 2.5	approx 12.5	approx 7.5	approx 57.5	approx 8.5	approx 3.5	approx 1.0	approx 1.5
Canton Ck.	1979	Glova and McCart, 1979	0+	approx 0.5	approx 0.5	approx 0.5	approx 1.0	approx 17.5	approx 46.5	approx 18.0	approx 11.0	approx 3.0	approx 1.0	approx 0.5	approx 0.5
Conuma R.	1979	Glova and McCart, 1979	0+	approx 1.5	approx 1.5	approx 0.5	0	approx 29.0	approx 29.0	approx 16.0	approx 13.5	approx 7.0	approx 1.0	approx 1.0	approx 1.0
Tlupana R.	1979	Glova and McCart, 1979	0+	<0.5	approx 1.0	approx 1.0	approx 0.5	approx 14.0	approx 49.5	approx 17.0	approx 10.0	approx 6.5	0	<0.5	<0.5
Little Qualicum R.	1979	Lister et al, 1979	0+												
			May 14-15	← 1.0 →				← 89.0 →			← 10.0 →				
			May 21-22	← 0.6 →				← 73.8 →			← 25.6 →				
			May 28-29	← 0.2 →				← 67.3 →			← 32.5 →				

* Pacific Standard Time.

APPENDIX C-13

Fork LENGTH (mm), Wet WEIGHT (g) and CONDITION of JUVENILES Sampled During Peak Migration

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In preparing the data for between-study comparisons, individual fish were categorized as emergent or rearing, using the timing of peak catches (See APPENDIX C-11). Consideration was also given to the capture technique used, as some methods (inclined plane traps and fyke nets) probably intercept migrants, while others (minnow traps, seines, dipnet and electrofishing) tend to capture non-migrants. Daily average lengths and weights were then calculated according to age class over the peak timing period and condition factors were derived which were then averaged for the season. Although chum salmon were considered to be largely emergent fry, some probably had reared; thus, condition factors for some stocks may be somewhat inaccurate. In many cases our estimates, which were based on changes in weight, length and/or developmental indices, did not reflect the conclusions of the source report authors.

Two different condition factors were calculated from length and weight data:

(1) $$K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$$ Bams' development factor for emergent fry

(2) $$K = \frac{100\ (\text{weight in mg})}{(\text{length in mm})^3}$$ Fulton's condition factor for rearing fry and fingerlings

Equation (1) specifically describes emergent fish and assumes some degree of yolk absorption. Equation (2) assumes that fish shape does not change as it grows, and is often used to describe differing condition factors between fish of similar lengths within a species. In this report, only emergent fry were described using the K_D development factor: K was used for all other fish.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE CHINOOK SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
					NORTH COAST					
Morice R.	1979	Smith and Berezay, 1983	0+	Apr 27	50	39.3±0.48	0.52±0.02	2.046	-	S.E. calculated from 95% confidence limits for lengths and weights given in source report.
			1+	Apr 25 - 30	50	83.6±2.93	7.67±0.79	-	1.313	as above
	1980	Smith and Berezay, 1983	0+	Apr 18	50	36.8±0.51	0.57±0.016	2.253	-	as above
Kitimat R.	1980	Birch et al, 1981	0+	Apr 9	16	39.5±2.2	0.43±0.07	1.911	-	
			1+	Apr 26	5	86.0±6.6	6.30±1.76	-	0.990	
Hirsch Ck.	1980	Birch et al, 1981	0+	Apr 11	50	39.4±0.57	0.40±0.01	1.870	-	
			1+	Apr 19	1	68.0	2.82	-	0.897	
Cecil Ck.	1980	Birch et al, 1981	0+	May 12	17	41.6±0.27	0.51±0.01	1.921	-	
Kildala R.	1981	Slaney et al, 1982	0+	Mar 31	10	39.8±1.08	0.42±0.06	1.882	-	emergents
			0+	June 5, 6, 8, 9	7	56.7±2.78	1.86±0.25	-	1.012±0.028	reared fry
			1+	Apr 26	6	80.6±5.56	4.98±0.99	-	0.94±0.09	
Dala R.	1981	Slaney et al, 1982	0+	Apr 2	5	38.8±1.60	0.34±0.04	1.799	-	
			1+	May 4	19	79.9±2.31	5.15±0.50	-	1.00±0.028	
					SOUTH COAST					
Sucwoa R.	1979	Glova and McCart, 1979	0+	Apr 25	10	42.7±0.6	0.56	1.930	-	source report did not provide S.E. for x weights.

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE CHINOOK SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
				SOUTH COAST - Cont'd						
Canton Ck.	1979	Glova and McCart, 1979	0+	May 1	29	41.3±0.4	0.54	1.972	-	source report did not provide S.E. for x weights.
Conuma R.	1979	Glova and McCart, 1979	0+	May 14	20	41.4±0.8	0.51	1.930	-	as above.
Tlupana R.	1979	Glova and McCart, 1979	0+	May 1	30	42.9±0.4	0.61	1.977	-	as above.
Deserted Ck.	1979	Glova and McCart, 1979	0+	Apr. 19	14	41.3±0.8	0.55	1.984	-	as above.
Little Qualicum R.	1979	Lister et al, 1979	0+	June 11-17	50	75.8±1.7	4.7±0.3	-	1.079	
				FRASER R., N.B.C. AND YUKON						
Holmes R.	1981	Rosberg et al, 1982	1+	overall	?	83.30	6.76	-	1.170	weight and K value may be misleading as many samples were slightly dessicated.
Morkill R.	1981	Rosberg et al, 1982	1+	overall	?	81.54	6.50	-	1.200	as above
Torpy R.	1981	Rosberg et al, 1982	1+	overall	?	83.97	6.40	-	1.081	as above
Slim Ck.	1981	Rosberg et al, 1982	1+	overall	?	80.92	6.00	-	1.132	as above
Bowron R.	1980	Murray, et al, 1981	0+ 0+ 1+	May 15 July 18 May 13-17	50 16 26	38±0.04 56±0.22 75.2±3.64	0.36±0.01 1.76±0.22 -	1.872 - -	- 1.002 -	emergents reared fry no weights were taken from 1+ fish.
Willow R.	1980	Murray et al, 1981	0+ 0+ 1+	May 22 July 17 May 26-31	48 58 11	38±0.07 57±0.15 86.9±3.96	0.38±0.03 1.93±0.16 7.01±1.02	1.906 - -	- 1.042 1.049±0.037	emergents reared fry

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE CHINOOK SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
FRASER R. N.B.C. AND YUKON - Cont'd										
Stuart R.	1980	Lister et al, 1981	0+	May 11-18	50	37.7±0.39	0.39±0.02	1.938	-	emergents
			0+	June 12-19	59	48.7±1.01	1.15±0.08	-	0.996	reared fry
			1+	May 9-24	7	72.9±6.07	3.82±1.17	-	0.947±0.111	
Quesnel R.	1979	Olmsted et al, 1980	0+	Aug. 2	10	55.8±3.86	2.06±	-	1.186	reared fry
	1980	Whelen et at, 1981	0+	Apr. 17	10	38.9±1.01	0.46±0.05	1.984	-	
			1+	June 14, 17	7	112.7±4.95	13.5±2.05	-	0.931±0.022	2 samples IPT captures, 5 samples Seine captures.
Eagle R.	1981	Whelen et al, 1982	0+	Apr. 16	10	38.3±1.01	0.37±0.04	1.874	-	samples captured by minnow trap.
			1+	May 22	4	88.3±8.30	7.63±2.26	-	1.087±0.151	
Salmon R.	1981	Whelen et al, 1982	0+	May 7	10	41.6±3.02	0.59±0.14	2.016	-	samples caught by minnow trap and seine.
			1+	overall	7	107.0	13.5	-	1.10	
Adams R. (lower)	1981	Whelen et al, 1982	0+	May 3	10	39.8±1.02	0.46±0.05	1.940	-	
			1+	Apr. 9	2	84.0±2.0	5.95±1.50	-	1.000±0.182	
South Thompson R	1981	Whelen et al, 1982	0+	May 9	10	38.2±1.29	0.43±0.05	1.976	-	samples captured by seine.
			1+	July 10	7	89.0±3.06	7.7±1.02	-	1.086±0.078	
Blue R.	1981	Scott et al, 1982	0+	Apr. 3	10	37.2±0.49	0.32±0.02	1.839	-	samples captured by minnow trap.
			1+	Apr. 16-28	3	58.0	2.2	-	1.04	
Finn Ck.	1981	Scott et al, 1982	0+	Apr. 18	10	37.1±0.54	0.41±0.03	2.002	-	method of capture is unknown.
			1+	unknown	6	84.2	7.0	-	1.05	
	1982	Stewart et al, 1983	0+	-	-	-	-	-	-	95% confidence limits
			1+	Apr. 27	9	93.3±5.57	-	-	-	

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[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE CHINOOK SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
				FRASER R. N.B.C. AND YUKON - Cont'd						
Lion Ck.	1981	Scott et al, 1982	0+	June 19, 20	3	41.7±3.3	0.72±0.23	-	0.993	reared fry
Raft R.	1981	Scott et al, 1982	0+	Apr. 22	10	37.5±1.17	0.39±0.04	1.948	-	
	1982	Stewart et al, 1983	0+	May 16	UK	approx 38.0	approx 0.40	approx 1.94	-	emergents
			0+	June 10	UK	approx 43	approx 0.78	-	approx 0.981	reared fry
Clearwater R.	1982	Stewart et al, 1983	0+	May 22	UK	approx 38.0	approx 0.28	approx 1.72	-	emergents
			0+	July 20	UK	approx 52.0	approx 1.60	-	approx 1.14	reared fry
			1+	overall	3	77.7	4.27	-	0.91	
Lemieux Ck.	1982	Stewart et al, 1983	1+	overall	43	68.4	3.42	-	1.07	
North Thompson R.	1981	Scott et al, 1982	0+	Apr. 28	10	39.0±1.12	0.47±0.05	1.994	-	emergents
			0+	June 11	10	45.0±3.44	0.97±0.31	-	1.06	reared fry
			1+	Apr. 20	60	84.4±1.41	6.34±0.33	-	1.054	samples captured by seine.
	1982	Stewart et al, 1983	0+	May 22	UK	approx 38.0	approx 0.35	approx 1.85	-	emergents
			0+	July 12	UK	approx 62.0	approx 2.25	-	0.94	reared fry
			1+	overall	99	77.6	5.56	-	1.19	

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE COHO SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
North Coast										
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	0+	May 8	10	35.1	0.38	2.06	-	
Morice R.	1979	Smith and Berezay, 1983	0+	June 6-11	2	83.5±9.0	7.96±2.77	-	1.367	reared fry
			1+	June 6-11	15	94.8	10.96	-	1.286	
			2+	June 6-11	2	124.0±2.0	24.57±3.16	-	1.289	
	1980	Smith and Berezay, 1983	1+	June 20-22	27	106.6	14.75	-	1.218	
			2+	June 20-22	16	109.5	15.13	-	1.152	
Kitimat R.	1980	Birch et al, 1981	0+	June 10	50	34.4±0.40	0.32±0.01	1.988	-	emergents
			0+	July 24	5	41.9±5.56	0.71±0.37	-	0.965	reared fry
			1+	Apr. 22	28	84.4±4.23	5.79±0.80	-	0.963	
			2+	Apr. 22	6	86.8±6.20	6.37±1.58	-	0.974	
Hirsch Ck.	1980	Birch et al, 1981	0+	June 3	52	35.0±0.42	0.31±0.01	1.934	-	
			1+	May 26	2	61.8±5.52	2.58±0.69	-	1.093	
Cecil Ck.	1980	Birch et al, 1981	0+	June 4	42	35.5±0.44	0.34±0.01	1.966	-	
			1+	April 14	27	72.3±5.48	3.84±0.52	-	1.016	
			2+	April 14	6	92.1±3.21	7.29±0.61	-	0.933	
Kildala R.	1981	Slaney et al, 1982	0+	June 4	10	35.3±0.89	0.33±0.04	1.964	-	
			1+	May 4	10	89.6±10.12	7.66±2.66	-	1.065	
			2+	May 4	4	106.9±3.80	13.01±1.46	-	1.065±0.12	
Dala R.	1981	Slaney et al, 1982	0+	May 24	10	35.6±0.83	0.30±0.03	1.880	-	
			1+	Apr. 29	10	77.6±5.65	4.67±0.96	-	1.00±0.12	
			2+	Apr. 29	8	92.3±3.92	8.13±1.32	-	1.03±0.05	
Bish Ck.	1981	Slaney et al, 1982	0+	May 23	10	34.4±0.74	0.37±0.03	2.087	-	
			1+	March 26	12	71.8±3.93	3.89±0.61	-	1.075	

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE COHO SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR K_D	CONDITION FACTOR K	COMMENTS
				SOUTH COAST						
Sucwoa R.	1979	Glova and McCart, 1979	0+	June 5	30	35.4±0.6	0.34	1.972	-	
			1+	overall	?	77.9	-	-	-	
Canton Ck.	1979	Glova and McCart, 1979	0+	May 28	28	36.3±0.6	0.35	1.941	-	
			1+	overall	?	86.1	-	-	-	
Conuma R.	1979	Glova and McCart, 1979	0+	June 5	29	35.7±0.6	0.32	1.916	-	
			1+	overall	?	85.2	-	-	-	
Tlupana R.	1979	Glova and McCart, 1979	0+	May 1	26	38.0±0.6	0.40	1.939	-	
			1+	overall	?	77.7	-	-	-	
Deserted Ck.	1979	Glova and McCart, 1979	0+	May 1	21	36.6±0.8	0.35	1.925	-	
			1+	overall	?	112.7	-	-	-	
Little Qualicum R.	1979	Lister et al, 1979	0+	May 21-27	87	35.8±0.41	0.36±0.02	1.991	-	
			1+	May 21-27	42	96.1±2.87	8.90±0.91	-	1.003	
Glendale Ck.	1983	Shepherd, 1984	0+	Apr 18-May 11	24	36.8±0.97	0.39±0.05	1.987		
			1+	Apr 22-May 11	14	79.2±30.86	5.86±5.56		1.072	
Tom Browne Ck.	1983	Shepherd, 1984	0+	Apr 18-May 14	27	36.1±2.82	.38±0.10	2.001		
				FRASER R., N.B.C. AND YUKON						
Quesnel R.	1980	Whelen et al, 1981	0+	May 28	10	31.5±0.80	0.24±0.03	1.973	-	emergents
			0+	July 22	5	44.0±2.53	0.86±0.08	-	1.010	reared fry
			1+	May 10	17	100	8.9	-	0.890	samples captured by seine.
Eagle R.	1981	Whelen et al, 1982	0+	April 21	10	35.1±1.78	0.34±0.05	1.988	-	emergents
			0+	June 15	10	44.5±6.56	1.05±0.49	-	1.192	reared fry
			1+	Apr. 26-30	16	78.0±4.66	5.22±0.82	-	1.100	samples captured by seine and minnow trap.
Salmon R.	1981	Whelen et al, 1982	0+	May 5	10	31.9±1.038	0.26±0.05	2.001	-	
			1+	Apr. 25	20	88.6±3.68	6.81±0.90	-	0.979	samples caught by minnow trap

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE COHO SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
FRASER R., N.B.C. AND YUKON - Cont'd										
Adams R.	1981	Whelen et al, 1982	0+	May 3	10	34.2±0.78	0.32±0.02	2.000	-	
			1+	April 14	20	79.3±3.77	4.78±0.65	-	0.959	samples caught by minnow trap
South Thompson R.	1981	Whelen et al, 1982	0+	Apr. 27-May 30	4	31.8±1.5	0.25±0.04	1.981	-	
Blue R.	1981	Scott et al, 1982	0+	April 23	10	34.4±0.80	0.27±0.04	1.876	-	
			1+	April 10	13	58.3±5.95	2.08±0.65	-	1.050	samples caught by minnow trap
Finn Ck.	1981	Scott et al, 1982	0+	July 3	10	31.9±1.05	0.27±0.03	2.026	-	
			1+	April 12	6	63.2±8.09	2.95±1.29	-	1.169	samples caught by minnow trap
	1982	Stewart et al, 1983	1+	overall	9	79±12	-	-	-	95% confidence limits
Lion Ck.	1981	Scott et al, 1982	0+	April 23	10	33.9±0.70	0.23±0.03	1.807	-	emergents
			0+	July 26	10	49.6±2.94	0.975	-	0.799	reared fry weight calculated from emigrant underyearling length-weight regression: lnw = 0.43 (lnl) - 1.15
			1+	May 1	22	78.9±2.50	5.33±0.51	-	1.085	
Raft R.	1981	Scott et al, 1982	0+	June 2	10	31.7±1.16	0.20±0.02	1.845	-	emergents
			0+	July 1	10	41.7±8.98	1.07±0.64	-	1.476	reared fry
			1+	Apr. 1	25	76.0±2.24	4.11±0.33	-	0.936	
	1982	Stewart et al, 1983	0+	June 30	7	approx 48.0	approx 1.10	approx 2.15	approx 1.00	peak migration-emergents & reared fry
			1+	overall	4	80.0	5.38	-	1.05	
Joseph Ck. (incl. tribs.)	1982	Stewart et al, 1983	1+	overall	6	105.2	13.04	-	1.12	

[1] condition expressed as $K_D = \frac{10 \sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE COHO SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
FRASER R., N.B.C. AND YUKON - Cont'd										
Lemieux Ck.	1982	Stewart et al, 1983	1+	overall	45	81.0	5.85	-	1.10	
Barriere R.	1982	Stewart et al, 1983	1+	overall	8	71.1	3.34	-	0.93	
North Thompson R.	1981	Scott et al, 1982	0+	April 30	7	33.4±1.05	0.26±0.04	1.911	-	
			1+	May 15-18	6	85.3±8.09	6.45±1.64	-	1.039	
	1982	Stewart et al, 1983	1+	overall	2	58.5±5.00	2.06	-	1.03	

[1] condition expressed as $K_D = \dfrac{10\ \sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \dfrac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE CHUM SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
					NORTH COAST					
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	0+	May 5	25	39.6	0.47	1.963	-	some reared fry were likely in sample.
Kitimat R.	1980	Birch et al, 1981	0+	Apr. 8	50	40.5±0.62	0.42±0.02	1.849	-	as above.
Hirsch Ck.	1980	Birch et al, 1981	0+	Apr. 23	50	39.7±0.51	0.37±0.02	1.808	-	as above.
Kildala R.	1981	Slaney et al, 1982	0+	March 8	10	40.2±0.38	0.37±0.02	1.786±0.025	-	as above.
Dala R.	1981	Slaney et al, 1982	0+	March 7	10	40.7±0.69	0.42±0.03	1.840±0.025	-	as above.
Bish Ck.	1981	Slaney et al, 1982	0+	March 17	10	40.9±0.65	0.36±0.02	1.739±0.02	-	
					SOUTH COAST					
Sucwoa R.	1979	Glova and McCart, 1979	0+	May 1	20	41.8±0.6	0.44	1.820	-	some reared fry possibly in sample
Canton Ck.	1979	Glova and McCart, 1979	0+	April 19	30	40.9±0.6	0.44	1.860	-	as above.
Conuma R.	1979	Glova and McCart, 1979	0+	April 19	30	40.6±0.4	0.47	1.915	-	as above.
Tlupana R.	1979	Glova and McCart, 1979	0+	April 25	30	40.5±0.4	0.46	1.906	-	as above.
Deserted Ck.	1979	Glova and McCart, 1979	0+	April 25	29	39.4±0.8	0.44	1.930	-	as above.
Little Qualicum R.	1979	Lister et al, 1979	0+	May 21-27	241	38.9	0.36	1.835	-	
Glendale Ck.	1983	Shepherd, 1984	0+	Apr 12-May 10	29	38.1±0.92	.33±0.03	1.808±.058	-	Daily averages
Tom Browne Ck.	1983	Shepherd, 1984	0+	Apr 3-21	19	38.4±1.37	.34±0.03	1.823±0.050	-	Daily averages

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE SOCKEYE SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
						NORTH COAST				
Morice R.	1979	Smith and Berezay, 1983	1+	May 24	12	84.6	6.37	-	1.052	
			2+	May 24	4	119.3	18.03	-	1.062	
	1980	Smith and Berezay, 1983	1+	May 18	86	90.0	6.97	-	0.928	
			2+	May 18	10	120.9	16.6	-	0.939	
Kildala R.	1981	Slaney et al, 1982	0+	July 1	5	29.4±0.27	0.16±0.01	1.847	-	
Dala R.	1981	Slaney et al, 1982	0+	April 8	5	28.4±1.47	0.12±0.01	1.737	-	
						SOUTH COAST				
Sucwoa R.	1979	Glova and McCart, 1979	0+	May 1	30	29.0±0.6	0.13	1.747	-	
Canton Ck.	1979	Glova and McCart, 1979	0+	April 25	30	29.1±0.2	0.13	1.741	-	
Conuma R.	1979	Glova and McCart, 1979	0+	May 7	25	28.2±0.4	0.15	1.884	-	
Tlupana R.	1979	Glova and McCart, 1979	0+	May 14	30	28.6±0.2	0.12	1.725	-	
Deserted Ck.	1979	Glova and McCart, 1979	0+	May 1	30	28.9±0.6	0.14	1.797	-	
			1+	overall	92	85.9±1.8	-	-	-	
Glendale, Ck.	1983	Shepherd, 1984	1+	Apr 22-May 8	14	80.2±5.92	4.71±1.35		0.903±0.195	
						FRASER R., N.B.C. AND YUKON				
Quesnel R.	1980	Whelen et al, 1981	0+	May 16	6	28.5±1.94	0.24±0.06	2.181	-	
			1+	overall	7	92.8	7.32	-	0.916	
Eagle R.	1981	Whelen et al, 1982	0+	May 9	7	25.7	0.11	1.864	-	
			1+	July 18	10	83.5	5.6	-	0.962	samples captured by seine.
Salmon R.	1981	Whelen et al, 1982	0+	May 5	7	34.9	0.37	2.057	-	samples captured by seine.
South Thompson R.	1981	Whelen et al, 1982	1+	June 14	2	135.5	20.8	-	0.836	

[1] condition expressed as $K_D = \frac{10\sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

FORK LENGTH (mm), WET WEIGHT (g) AND CONDITION[1] OF JUVENILE PINK SAMPLED[2] DURING PEAK MIGRATION

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	SAMPLING PERIOD	n	LENGTH (mm)	WEIGHT (g)	CONDITION FACTOR		COMMENTS
								K_D	K	
					NORTH COAST					
Mathers Ck.	1979	Northern Natural Resource Services Ltd.	0+	April 29	25	35.5	0.28	1.849	-	
Kitimat R.	1980	Birch et al, 1981	0+	April 9	40	34.4±0.76	0.24±0.01	1.810	-	
Hirsch Ck.	1980	Birch et al, 1981	0+	April 23	50	35.7±0.31	0.25±0.01	1.765	-	
Kildala R.	1981	Slaney et al, 1982	0+	March 25	10	34.7±0.70	0.20±0.02	1.685±0.044	-	
Dala R.	1981	Slaney et al, 1982	0+	April 2	10	34.6±0.44	0.19±0.01	1.662±0.032	-	
Bish Ck.	1981	Slaney et al, 1982	0+	March 26	10	34.9±0.53	0.20±0.01	1.676±0.038	-	
					SOUTH COAST					
Sucwoa R.	1979	Glova and McCart, 1979	0+	April 19	13	35.1±0.8	0.22	1.720	-	
Canton Ck.	1979	Glova and McCart, 1979	0+	April 19	19	33.7±1.2	0.18	1.675	-	
Conuma R.	1979	Glova and McCart, 1979	0+	April 19	7	33.7±1.6	0.19	1.706	-	
Tlupana R.	1979	Glova and McCart, 1979	0+	April 19	4	35.0±1.4	0.23	1.751	-	
Glendale Ck.	1983	Shepherd, 1984	0+	Apr 8-25	18	34.1±0.79	0.22±0.02	1.753±0.039	-	
Tom Browne Ck.	1983	Shepherd, 1984	0+	Apr 2-26	25	34.2±0.082	0.22±0.02	1.748±0.050	-	

[1] condition expressed as $K_D = \frac{10\ \sqrt[3]{\text{weight in mg}}}{\text{length in mm}}$ (for emergent fry) or $K = \frac{100 \times \text{weight in mg}}{(\text{length in mm})^3}$ (reared fry and yearlings)

[2] all parameters ± 2 S.E.

APPENDIX C-14

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE MIGRATIONS

Almost all studies associated downstream migration with monitored changes in water temperature and river discharge. However, to identify these factors as migration triggers may be inaccurate. In these tables, all observations are treated subjectively and the reader is advised to refer to the source documents for more detailed information.

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE CHINOOK MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)	YEARLLNGS (1+)
NORTH COAST				
Morice R.	1979	Smith and Berezay, 1983	Increases in migration coincided with increasing temperature and flow.	-
	1980	Smith and Berezay, 1983	Increase in river height possibly affected peaking of migration	-
Kitimat R.	1980	Birch et al, 1981	a peak in reared fry migration roughly corresponded with a peak in discharge	-
Hirsch Ck.	1980	Birch et al, 1981	a peak in reared fry migration corresponded with a peak in discharge	-
Kildala & Dala R's.	1981	Slaney et al, 1982	main migrations followed storm freshets in both streams	-
SOUTH COAST				
Sucwoa R.	1979	Glova and McCart, 1979	a large number of migrants flushed out during flood.	-
Canton Ck.	1979	Glova and McCart, 1979	as for Sucwoa R.	-
Conuma R.	1979	Glova and McCart, 1979	as for Sucwoa R.	-
Tlupana R.	1979	Glova and McCart, 1979	as for Sucwoa R.	-
Fraser R., N.B.C. and Yukon				
Holmes R.	1981	Rosberg et al, 1982	decreasing flows, causing a reduction in rearing area, caused increase in migration	Increasing temperature was the major factor in migration response
Morkill R.	1981	Rosberg et al, 1982	decreasing flows caused increase in migration	as for Holmes R.
Torpy R.	1981	Rosberg et al, 1982	as for Morkill	as for Holmes R.
Slim Ck.	1981	Rosberg et al, 1982	as for Morkill	as for Holmes R.

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE CHINOOK MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)	YEARLLNGS (1+)
			FRASER R., N.B.C. AND YUKON - Cont'd	
Bowron R.	1980	Murray et al, 1981	water temperature, discharge rate, and lunar periodicity all affected migration timing	as for Holmes R.
Willow R.	1980	Murray et al, 1981	increasing water temperature affected migration timing	as for Holmes R.
Stuart R.	1980	Lister et al, 1981	increasing water temperature coincided with increasing migration	-
Salmon R.	1981	Whelen et al, 1982	-	initial discharge peak coincided with peak in migration.
Adams R.	1981	Whelen et al, 1982	rapidly increasing flow was responsible for peak in emigration	-
South Thompson R.	1981	Whelen et al, 1982	substantial increases in discharge generally triggered peaks in migration	-
Finn Ck.	1981	Scott et al, 1982	peak emigration coincided with an initial increase in discharge	-
Raft R.	1981	Scott et al, 1982	initial increases in both water temperature and discharge coincided with emigration peak	
North Thompson R.	1981	Scott et al, 1982	as for Raft R.	-

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE COHO MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)	YEARLINGS (1+)
SOUTH COAST				
Sucwoa R.	1979	Glova and McCart, 1979	-	the peak catch occurred during a flood.
Canton Ck.	1979	Glova and McCart, 1979	-	the peak catch occurred on the 1st day of a major flood, no smolts were captured during a 10 day period of low flow.
Conuma R.	1979	Glova and McCart, 1979	-	as for Canton Ck.
Tlupana R.	1979	Glova and McCart, 1979	-	the peak in migration coincided with the day of peak discharge.
FRASER R., N.B.C. AND YUKON				
Eagle R.	1981	Whelen et al, 1982	Increasing migration coincided with increasing discharge.	-
Salmon R.	1981	Whelen et al, 1982	peak migration occurred over a period of decreasing discharge.	emigration rate was highest during peak discharge.
Adams R. (lower)	1981	Whelen et al, 1982	peak emigration occurred during increasing discharge.	emigration timing linked to increasing discharge.
Blue R.	1981	Scott et al, 1982	peak emigration was coincident with initial peak in water temperature.	-
Finn Ck.	1981	Scott et al, 1982	peak emigration occurred during decreasing flows and increasing water temperatures.	-
Lion Ck	1981	Scott et al, 1982	peak emigration occurred during increasing water temperature and increasing discharge.	-
Raft R.	1981	Scott et al, 1982	peak emigration occurred during decreasing discharge and increasing temperature.	-
North Thompson R.	1981	Scott et al, 1982	peak emigration occurred during increasing discharge and increasing temperature.	-

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE CHUM MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)
			NORTH COAST
Hirsch Ck.	1980	Birch et al, 1981	Colder water temperatures (than in the Kitimat R.) were thought to have had a delaying effect on outmigration in this tributary stream.
Kildala R.	1981	Slaney et al, 1982	Early peaks in migration occurred during increases in discharge, while secondary peaks later on were not related to water levels.
Dala R.	1981	Slaney et al, 1982	The major peak period in migration coincided with a storm-induced freshet.
			SOUTH COAST
Sucwoa R.	1979	Glova and McCart, 1979	Timing of peak emigration coincided with the peak in zooplankton abundance.
Canton Ck.	1979	Glova and McCart, 1979	as for Sucwoa R.
Conuma R.	1979	Glova and McCart, 1979	as for Sucwoa R.
Tlupana R.	1979	Glova and McCart, 1979	as for Sucwoa R.
Deserted Ck.	1979	Glova and McCart, 1979	as for Sucwoa R.
Tom Browne Cr.	1983	Shepherd, 1984	Peak emigration coincided with 1,000 ATUs, calculated from subgravel water temperatures.
Glendale Cr.	1983	Shepherd, 1984	as for Tom Browne Cr.

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE SOCKEYE MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)	YEARLINGS (1+)
			NORTH COAST	
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	-	Migration peaks corresponded with peaks in discharge
			SOUTH COAST	
			No Information	
			FRASER R., N.B.C. AND YUKON	
Quesnel R.	1980	Whelen et al, 1981	-	Peak migration coincided with rapidly increasing flow

BIOPHYSICAL FACTORS WHICH MAY AFFECT JUVENILE PINK MIGRATIONS

STREAM	YEAR	SOURCE	EMERGENTS & REARED FRY (0+)
			NORTH COAST
Mathers Ck.	1979	Northern Natural Resource Services Ltd., 1979	Increases in migrant numbers were related to increases in discharge.
			SOUTH COAST
Tom Browne Cr.	1983	Shepherd, 1984	Peak emigration coincided with 950 ATUs, calculated from subgravel water temperatures.
Glendale, Cr.	1983	Shepherd, 1984	as for Tom Browne.

APPENDIX C-15

REARING DISTRIBUTIONS of Juveniles

Juvenile salmon were captured and recorded using various combinations of minnow traps, seines, visual inspection, electrofishing, dipnetting, angling, snorkelling and gillnetting. These tables contain subjective notes on the habitat type, river location, degree of concentration and migratory routes for 0+ and 1+ juveniles. The "methods" column refers to observation methods rather than the overall strategy used to determine distribution (eg. mark recapture). All kilometer values denote distances above the stream mouth unless otherwise indicated.

REARING DISTRIBUTIONS OF CHINOOK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
NORTH COAST					
Morice R.	1979	Smith and Berezay, 1983	MT	0+	Catch per unit effort was highest, overall, from Lamprey Creek to a point 7.5 km downstream. Generally, the lower 9 km approx. and the area beginning 7.5 km below Lamprey Creek and ending at the Goswell Creek confluence, was preferred by rearing chinook.
Kitimat R.	1980	Birch et al, 1981	MT, SN, EF	0+	Juveniles were present throughout most of the lower system including the mainstem, the lower portions of Hirsch, Humphreys, Cecil, Crist and Nalbeelah Creeks, and the Big and Little Wedeene Rivers. Rearing was also noted in the upper Big Wedeene River (below Aveling Creek), McKay and Hunter Creeks, the mouth of Davies-Hoult Creeks and the Kitimat River headwaters. The highest catch over a given period occurred on lower Hirsch Creek.
SOUTH COAST					
Mussel Ck.	1983	Whelen et al, 1984	MT	0+	Juveniles were absent from this system and likely rear in the Kilnakilni mainstem.
FRASER R., N.B.C. and YUKON					
Fraser R. (mainstem)	1981	Rosberg et al, 1982	MT, SN, DN	0+	The entire study area, from Penny to McBride, is utilized by rearing fry. Extensive backwater areas, side channels and marginal debris dams provide good rearing habitat.
Holmes R.	1981	Rosberg et al, 1982	MT, SN, DN, EF,	0+	Sampling sites were located between km 0.5 and 18.0. In the lower areas, large backwaters behind logjams are primary rearing sites, while small backwaters and side channels are utilized in the upstream portions.
Morkill R.	1981	Rosberg et al, 1982	EF, MT, SN	0+	The distribution of underyearlings in this system appears restricted to the mainstem between the mouth and a point between Hellroaring and Forget-Me-Not Creeks. Much of the rearing area was comprised of river margins and the inside portion of meanders. Both actual and potential use of this system by rearing chinook was assessed as low.
Torpy R.	1981	Rosberg et al, 1982	EF, MT, SN	0+	Rearing fry were present in the mainstem to a point 1 km above Pass Lake Creek mouth, and in several tributaries, namely, Walker Creek (lower 10 km approx.), Goodson Creek, Humbug Creek and West Torpy River (to headwaters). Preferential habitat for rearing included areas having slow flow, undercut banks and/or debris accumulations.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF CHINOOK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
			FRASER R., N.B.C. and YUKON - Cont'd		
Slim Ck.	1981	Rosberg et al, 1982	EF, MT, SN, DN, AN	0+	Fry were encountered over the entire length of stream from the mouth to Centennial Creek, including Slim and Tumuch Lakes and the mouth area of Everett Creek. Whether fry captured in Slim and Tumuch Lakes were transient or actually rearing was not successfully determined. The most productive capture sites were located in a beaver pond near the mouth, in Slim Lake and a backwater area adjacent to the major spawning grounds below Slim Lake.
Bowron R.	1980	Murray et al, 1981	SN, EF	0+	Catch per unit effort was relatively uniform for all sampling stations, from the hwy. #16 crossing to Bowron Lake. Fry were abundant in several tributaries, namely Towkuh, Craze, 10-Mile, 14-Mile, 18-Mile, Tsus and Swamp Creeks. Low numbers of rearing chinook were captured in Sow, Purden and Grizzly Creeks.
Willow R.	1980	Murray et al, 1981	SN, EF	0+	Rearing chinook were captured throughout the mainstem between the mouth and a point approx. 4 km downstream of the Hwy. 16 crossing. Rearing utilization was highest between approx. 15 and 28 km from the mouth. Habitats in tributary streams were not considered as valuable for rearing with the exception of Tsadesta Creek, although catches were documented in Bowes and Wansa Creeks.
Stuart R.	1980	Lister et al, 1981	SN, EF, MT	0+	The highest densities of rearing fry were encountered between Stuart Lake and Dog Creek in the mainstem, while numerous tributaries contained rearing activity. Kec, Mud, Welch and Chinohchay Creeks all contained densities comparable with or higher than those found in prime rearing areas of the mainstem. The highest single catch (by density) was recorded on Creek "A", which enters the Stuart approx. 10 km below Stuart Lake, at Six Mile Island.
Nechako R.	1979	Olmsted et al, 1980	MT, SN	0+	Sampling was conducted between Cheslatta Falls and a point approx. 10 km downstream of Greer Creek. Sites of intensive utilization were scattered throughout this area but were most concentrated around Greer Creek and over the lower 4 km of Swanson Creek, two tributaries to the mainstem.
Horsefly R.	1979	Olmsted et al, 1980	MT, SN	0+	Sampling locations were not well-distributed and thus, some principal rearing areas may have been overlooked. However, it appears that rearing occurred throughout much of the mainstem from the outlet at Quesnel Lake upstream to the McKinley Creek confluence and in two tributaries, McKinley and Patenaude Creeks. Intensive rearing occurred in the mainstem, between Patenaude and McKinley Creeks.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF CHINOOK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
FRASER R., N.B.C. and YUKON - Cont'd					
Quesnel R.	1979	Olmsted et al, 1980	MT, SN	0+	As with the Horsefly River, sampling locations were limited by access and a complete picture of rearing distribution is not available. However, over the sections sampled, a 1 km area above Likely and another similar in length, near the Cariboo River confluence, were well utilized by rearing fry.
	1980	Whelen et al, 1981	MT, SN	0+	Sampling locations were similar to those adopted in 1979 but distributions were somewhat altered, as the main rearing area occurred between 0.5 and 1.0 km upstream from the Cariboo River. An area of moderate utilization occurred over an area situated approx. 1.5 km either side of the road crossing at Likely.
Middle Shuswap R.	1983	Fee and Jong, 1984	EF, SN, SK	unspecified	Juvenile chinook were present throughout suitable habitat from about 4 km above the outlet at Mabel Lake to approx. 2 km above Bessette Creek. Utilization generally increased with distance from the mouth.
Bessette Ck.	1983	Fee and Jong, 1984	EF, SN	unspecified	Abundance of rearing chinook was classed as low throughout the accessible length of the mainstem and in 2 principal tributaries, Duteau and Creighton Creeks.
Trinity Ck.	1982	Sebastian, 1983	EF	0+	Very low densities of chinook fry were present in the lower 1.1 km of stream, and although an additional 0.4 km of stream is accessible, it was not utilized during the period of study.
Eagle R.	1981	Whelen et al, 1982	MT, SN	0+	Numerous areas exist where habitat is suitable for rearing and the most extensively utilized were located: (1) near Malakwa, (2) between the Perry R. confluence and Kay Falls and, (3) approx. 0.5 km above and below Mitikan Creek.
Crazy Ck.	1982	Sebastian, 1983	EF	0+	Anadromous rearing habitat was restricted to the lower 300 m of stream. Fry densities in this area were very low.
Perry R.	1982	Sebastian, 1983	EF, ?	0+	Rearing occurs in stream margin and side channel habitat over the lower 200m of stream.
Salmon R.	1981	Whelen et al, 1982	SN, MT	0+	In the areas surveyed, utilization was greatest between Stephen Creek and Falkland. Chinook underyearlings were captured in numerous locations throughout the area, from the river mouth upstream to a point approx. 18 km above Falkland.
				1+	Low numbers of yearlings were captured at several points along the lower 38 km of river, the greatest proportion of which occurred over the upper portion.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF CHINOOK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
					FRASER R., N.B.C. and YUKON - Cont'd
Seymour R.	1982	Sebastian, 1983	EF, SK	0+	Fry were encountered in low densities between the mouth and the McNomee Creek confluence.
				1+	Yearlings were present in somewhat greater abundance than fry over the same section of stream (indicated above).
Adams R.	1981	Whelen et al, 1982	SN, MT	0+	Rearing areas were identified between the mouth and Hiuihill Creek, while the most abundant rearing populations were located around the Hiuihill Creek mouth, around the lower bridge crossing and at the mouth.
South Thompson R.	1981	Whelen et al, 1982	SN, MT	0+	Rearing occurred throughout the area surveyed from Shuswap Lake to 2 km below Pritchard, while the foreshores at either end of Little Shuswap Lake and an area at the mouth of Niskonlith Creek were the most utilized.
Blue R.	1981	Scott et al, 1982	SN, MT	0+	Rearing fry were present in low numbers over portions of the lower 11.5 km of stream (several areas within this area were not surveyed), although the greatest proportion were found between the CNR bridge and the mouth.
				1+	Three yearlings were caught between the CNR bridge and the mouth, indicating this as being possibly the preferred rearing area.
Finn Ck.	1981	Scott et al, 1982	SN, MT	0+	The areas of most intensive utilization by rearing fry appeared to lie just downstream of the hwy. bridge and over the lower 1.0 km, although much of the area falling between these 2 sections was not surveyed.
	1982	Stewart et al, 1983	SN, EF	0+	Low densities of rearing fry were encountered from the hwy. bridge downstream to the mouth.
Lion Ck.	1981	Scott et al, 1982	MT	0+	Limited rearing occurred between the access road and CNR bridges.
Raft R.	1981	Scott et al, 1982	MT, SN	0+	Rearing occurred over the lower 3.5 km of stream and was most intensive for the first 2.0 km approx. below the hwy. bridge.
	1982	Stewart et al, 1983	EF, SN	0+	The rearing area was similar to that encountered in 1981 but only low fry densities were encountered.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF CHINOOK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
					FRASER R., N.B.C. and YUKON - Cont'd
Clearwater R.	1982	Stewart et al, 1983	EF, SN	0+	Rearing fry were captured at various locations over the lower 37 km of stream, approximately, and densities were typically low.
Joseph Ck. (incl. tribs.)	1982	Stewart et al, 1983	EF, ?	0+	Although 0+ fish were captured in this stream, the absence of fry following emergent migration is a likely indication that rearing is conducted outside this system (ie. in the North Thompson River).
Lemieux Ck.	1982	Stewart et al, 1983	EF, ?	0+	as above
Barriere R. (incl. tribs)	1982	Stewart et al, 1983	EF, ?	0+	as above
North Thompson R.	1981	Scott et al, 1982	SN, MT	0+	Rearing fry were distributed throughout the study area, from approx. 5 km below Little Fort to Vavenby. In all the areas sampled, rearing was intensive.
				1+	The majority of yearling chinook were captured between Blackpool and Clearwater, although captures were documented over the entire study area. It is not known whether these fish were rearing or were merely emigrants. However, due to the decline in captures following peak freshet it is likely that most yearlings did not remain to rear for a second summer.
	1982	Stewart et al, 1983	EF, ?	0+	Generally, fry densities were higher in the mainstem than in any of the tributaries studied. Rearing fry were encountered in various locations of the area surveyed, between Barriere and Finn Creek, with the highest occurrence from Barriere to Blackpool. Rearing did not occur over an approx. 6 km section beginning approx. 8 km above Vavenby.
	1982	Stewart et al, 1983	EF, ?	1+	Captures of yearlings occurred generally throughout the areas sampled for fry, although by July the area between Blackpool and approx. Vavenby contained the only yearling populations.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF COHO JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
				NORTH COAST	
Morice R.	1979	Smith and Berezay, 1983	MT	0+	The preferred area for rearing extended from the Morice Lake outlet to a point approx. halfway between Lamprey and Owen Creeks, while the section running between the Thautil River and Lamprey Creek contained 60% of the fish captured.
Kitimat R. (incl. tribs.)	1980	Birch et al, 1981	MT, SN, EF	0+ 1+	Rearing coho were found throughout the accessible portions of the mainstem and tributaries utilized by spawning adults and consisting of suitable habitat. as above
Kwatna R.	1983	Rice, 1984	VI, AN, MT	unspecified	Juveniles were distributed from the mouth to km 22.8, while the highest concentrations were encountered between km 11 and 15.6.
Gus Ck.	1983	Rice, 1984	VI	unspecified	Juveniles were observed between the bridge and the mouth; most were located in a deep pool at the mouth.
Oak-Beck Ck.	1983	Rice, 1984	VI	unspecified	Juveniles were observed in the west fork.
Slousiska Ck.	1983	Rice, 1984	VI, MT	unspecified	Juveniles were widely distributed below the waterfall.
Quatlena R.	1983	Rice, 1984	VI	unspecified	Rearing was observed between km 0.8 and 2.1.
Nootum R.	1983	Rice, 1984	VI	unspecified	Rearing occurred between the mouth and km 3.5.
				SOUTH COAST	
Glendale/Tom Browne Cks.	1983	Whelen and Morgan, 1984	MT, VI	0+ & 1+	Substantial numbers of juveniles were observed in pools throughout the accessible portions of both Tom Browne and Glendale Creeks.
Mussel Ck.	1983	Whelen and Morgan, 1984	MT	0+ & 1+	Although rearing juveniles were observed throughout the survey area, 94% of the captures were made from large pools located within the lower 1.2 km of stream.
Kilnakilni R.	1983	Whelen and Morgan, 1984	MT	0+	Dice Creek was the only location from which captures were made (n=6).
Ahnuhati R.	1983	Whelen and Morgan, 1984	MT, VI	0+	Fry were observed throughout the area located between 1.0 and 7.0 km from the mouth.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF COHO JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
					FRASER R., N.B.C. and YUKON
Horsefly R.	1979	Olmsted et al, 1980	MT, SN	unspecified	Juveniles were sampled throughout the mainstem below McKinley Creek, save the section between Hooker Creek and the Little Horsefly River. Abundance was greatest between McKinley Creek and Patenaude Creek. Limited numbers of coho were also captured from McKinley Creek.
Quesnel R.	1980	Whelen et al, 1981	MT, SN	0+	Captures of fry were made at Quesnel Forks (86%) and the "Burling Pond" (14%) near Likely.
				1+	Six yearling coho were caught in the Burling Pond; no other captures were documented.
Middle Shuswap R.	1983	Fee and Jong, 1984	EF, SN, SK	0+	Coho rearing was restricted to the lower 23 km of stream, although the lower portion of this (length unspecified) contains no rearing coho.
Bessette Ck. (incl. tribs.)	1983	Fee and Jong, 1984	EF, SN	0+	Fry were found throughout the anadromous sections of Bessette, Duteau and Creighton Creeks in low, moderate and very low abundance, respectively.
Trinity Ck.	1982	Sebastian, 1983	EF	0+	Very low densities of fry were present over the lower 1.1 km of this stream.
Eagle R.	1981	Whelen et al, 1982	MT, SN	0+	Rearing coho were distributed from the river mouth at Shuswap Lake upstream to Victor Lake. Primary concentrations were found between the Perry River and Crazy Creek, between Mitikan and Tumbler Creeks and at several locations between Three Valley and Victor Lakes. Generally, use of rearing areas upstream of Yard Creek was moderate heavy, as this portion of the river was more suitable for rearing than the downstream area.
				1+ & 2+	Yearlings and post-yearlings were sampled at various locations between Shuswap Lake and the head of Three Valley Lake, while highest CPUE occurred between Kay Falls and Tumbler Creek and from the head of Griffin Lake to the head of Three Valley Lake.
South Pass Ck.	1982	Sebastian, 1983	EF	0+ & 1+	Although the anadromous section extends for 1.2 km above Three Valley Lake, the area suitable for rearing terminates at the 0.7 km point.
Crazy Ck.	1982	Sebastian, 1983	EF, SK	0+	Coho fry density is very low and is confined to the lower 0.6 km of stream.
Perry R.	1982	Sebastian, 1983	EF	0+	Low numbers of coho were found in the lower 0.9 km of stream.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF COHO JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
					FRASER R., N.B.C. and YUKON - Cont'd
Salmon R.	1981	Whelen et al, 1982	MT, SN	0+	The river was utilized from the foreshore of Shuswap Lake near the mouth upstream to approx. 14 km above Falkland. Extensively utilized areas were scattered between Stephen and Bolean Creeks. However, as many areas were not surveyed, extensive utilization may have occurred elsewhere.
				1+	Yearlings were distributed between the river mouth and Falkland, with the highest concentrations occurring between Apelmer and Gordon Creeks; the highest CPUE was also recorded in this section.
Tappen Ck.	1982	Sebastian, 1983	EF	0+	Fry were present over the lower 1.5 km of stream, with the highest densities occurring in the first 300 m.
Seymour R.	1982	Sebastian, 1983	EF, SK	0+ & 1+	Fry and yearlings were present along stream margins to km 4.5.
McNomee Ck.	1982	Sebastian, 1983	EF	0+ & 1+	Coho were present to km 2.3 in densities some 4 times higher than those found for the Seymour River (reach average).
Adams R. (lower)	1981	Whelen et al, 1982	MT, SN	0+	Underyearlings were found in most areas sampled, between Adams Lake and Shuswap Lake but were concentrated over 3 small sections located at: (1) approx. 1 to 2 km above the mouth, (2) just above the lower bridge crossing and (3) around the mouth of Hiuihill Creek (coho also utilized the lower portion of Hiuihill Creek).
				1+	Yearlings were concentrated over the lower 2.5 km of stream, although most of the captures were made in April and May, indicating that most yearlings do not rear for a second summer.
South Thompson R.	1981	Whelen et al, 1982	SN	0+	Limited numbers of fry reared in the South Thompson, as indicated by the total catch (n=102). The majority were found in Little Shuswap Lake and the lower portion of the Little River.
				1+	Based on limited data, it would appear that most of the population reared along the eastern foreshore of Little Shuswap Lake and in the lower half of the Little River.
Albreda R.	1982	Hutton et al, 1983	MT	0+	Only a limited number of locations were sampled but from the available data it appears that distribution was restricted to the upper portion of stream, beginning at approx. km 11.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF COHO JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
FRASER R., N.B.C. and YUKON - Cont'd					
Blue R.	1981	Scott et al, 1982	MT, SN	0+	This stream was utilized over much of the lower 12.5 km and was extensively utilized between the mouth and the hwy. bridge.
				1+	Distributions were similar to those documented for 0+ fish.
Goose Ck.	1982	Hutton et al, 1983	MT	unspecified	Captures (n=6) were made immediately above and below the hwy crossing. Although sampling was confined to this relatively short stretch of stream, conditions appear good for rearing over much of the stream's length.
Peddle Ck.	1982	Hutton et al, 1983	MT	0+ & 1+	A substantial number (n=159) of juveniles were trapped from a swampy area adjoining Peddle Creek. The rearing area is restricted to the lower 0.6 km of Peddle Creek and the surrounding swampy areas.
Finn Ck.	1981	Scott et al, 1982	SN, MT	0+	Coho fry were distributed between the confluence with the North Thompson River and a point approx. 400 m upstream of the hwy. crossing. Rearing appeared to be most concentrated over the lower 1 km but very little sampling was conducted over the next 2.5 km and the relative abundance is largely unknown.
				1+	Distribution and abundance patterns were similar to those given for 0+ fish.
	1982	Stewart et al, 1983	SN, MT	0+	Very low densities of fry occurred between the mouth and the hwy. crossing.
Lion Ck.	1981	Scott et al, 1982	SN, MT	0+	Fry were distributed throughout the lower 1.5 km of this stream and were most concentrated between the access road bridge and the CNR crossing.
				1+	Distribution and abundance were similar to those discussed for 0+ fish, although a higher utilization was made of the lower section of the stream.
Wire Cache Ck.	1982	Hutton et al, 1983	MT	0+ & 1+	Substantial numbers of reared fry and yearlings were caught over the lower 0.3 km of stream (n=2906) during the fall and again during the winter (n=198, total effort=18.0 trap hours), suggesting that this small stream is important both as a rearing area and as an overwintering area. It is believed that many of these fish were immigrants from upstream locations of the North Thompson drainage.
Raft R.	1981	Scott et al, 1982	MT, SN	0+	Coho fry were distributed from the mouth area to approx. 600 m upstream of the hwy. bridge. The areas of most concentrated rearing were located within the lower 1 km of river. As reported for Wire Cache Creek, it is believed that immigration of underyearling coho from the North Thompson River occurred.
			SN	1+	Distribution was similar to that given for fry but as no captures were made after May, it is possible that no summer rearing took place.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkelling; GN - Gill Netting

REARING DISTRIBUTIONS OF COHO JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
FRASER R., N.B.C. and YUKON - Cont'd					
Clearwater R.	1982	Stewart et al, 1983	EF, SN	1+	Very low densities of yearlings were present between km 14 and 18, although certain margin areas contained substantial numbers.
Dunn Ck.	1982	Stewart et al, 1983	EF, ?	0+	Reared fry appeared in catches (at low densities) during fall surveys over the lower 2.5 km of stream.
				1+	Yearlings exhibited a similar pattern of distribution and abundance to that described for 0+ fish but, as catches dropped off in May, it seems likely that no summer rearing took place.
McTaggart Ck.	1982	Stewart et al, 1983	EF, ?	0+	Early summer fry densities were higher here than in other Joseph Creek tributaries. Specifics on distribution were not available but, as the entire stream contains suitable conditions for rearing, it is assumed that fry occur throughout.
Lemieux Ck.	1982	Stewart et al, 1983	EF, ?	0+ & 1+	Data suggest that fry rear throughout the anadromous section of stream but drop down into the lower reaches to overwinter.
Barriere R.	1982	Stewart et al, 1983	EF; ?	0+	Fry captures were made in survey areas from the North Thompson confluence to km 37 (not including North Barriere Lake). The highest densities were present in the lower 5 km of stream.
East Barriere R.	1982	Stewart et al, 1983	EF, ?	0+	Fry were present over the lower 5 km during June but, as effort did not extend beyond this area, upstream distribution and abundance is unknown.
	1982	Hutton et al, 1983	MT	unspecified	Limited catches of coho (n=14) were made between the confluence with the Barriere River and the outlet of East Barriere Lake.
Louis Ck.	1982	Hutton et al, 1983	MT	0+ & 1+	Fry and yearling coho were distributed between approx. km 13.5 and km 45, with the majority utilizing the upstream portion of this area (km 42-45). Although the survey failed to include the section of stream below km 13, the likelihood of substantial rearing activity is poor, due to high velocity and unsuitable substrate.
North Thompson R.	1981	Scott et al, 1982	MT, SN	0+	As effort was not continuous for each section throughout the study period, an accurate description of distribution is not practical. However, it appears that abundance was greatest towards the upper and lower ends of the survey area, which were, respectively, Raft River-Vavenby and Little Fort. The highest occurrances were just downriver from Vavenby.
				1+	Although captures were made at various sites throughout the study area, their early emigration (most captures were made in April and May) suggests that only limited summer rearing occurs among yearlings.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF CHUM JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
				NORTH COAST	
Kitimat R. (tribs.)	1980	Birch et al, 1981	MT, SN, EF	0+	Chum fry reared for a short period of time in the lower reaches of the following streams: Hirsch, Nalbeelah and Humphreys Creeks, and the Big Weedene River.
				SOUTH COAST	
---------- no information ----------					
				FRASER R., N.B.C. and YUKON	
---------- no information ----------					

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF SOCKEYE JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
NORTH COAST					
------------ no information ------------					
SOUTH COAST					
------------ no information ------------					
FRASER R., N.B.C. and YUKON					
Bowron R.	1980	Murray et al, 1981	SN	0+	A limited number of sockeye (n=8) were caught 0.5 km downstream from the outlet of Bowron Lake; these were believed to be strays from the lake-rearing population.
Quesnel R.	1980	Whelen et al, 1981	SN	0+	Although fry catches occurred at nearly all survey sites between Quesnel Forks and Quesnel Lake, virtually all captures were recorded from 2 sites located approx. 0.5 km upstream from the Likely Bridge, near the Quesnel Lake outlet.
Eagle R.	1981	Whelen et al, 1982	SN	0+	Virtually all rearing took place between the river mouth and the Camble Bridge crossing, although the most likely nursery area would be Shuswap Lake.
Salmon R.	1981	Whelen et al, 1982	SN	0+	The majority of underyearlings were found below Stephen Creek to the mouth. However, as very few captures were evident after early June and the obvious sockeye rearing area is Shuswap Lake (into which the Salmon River drains), it seems likely that few sockeye encountered were rearing. Two yearling sockeye captured may be indicators of residualization among small numbers of this stock.
South Thompson R.	1981	Whelen et al, 1982	SN	0+ & 1+	Most juveniles encountered were seined from the foreshore areas of Little Shuswap Lake (east end) and Shuswap Lake (west end).
Raft R.	1981	Scott et al, 1982	SN	0+	Virtually all captures were made between km 1.0 and the highway bridge, and were probably all migrants, rather than rearing fry. No yearlings were encountered.
North Thompson R.	1981	Scott et al, 1982	SN	0+	The majority of sockeye were caught between approx. Little Fort and Mann Creek. It is likely that many of these were rearing.
	1982	Stewart et al, 1983	EF?	0+	High smolt densities were encountered at points along the river from Barriere to the Vavenby area, suggesting that this section contains suitable rearing sites.
	1982	Hutton et al, 1983	MT	1+ ?	Twenty-one juveniles were caught in a shallow, still side-channel near Little Fort on January 7; these fish appeared to be overwintering yearlings.

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

REARING DISTRIBUTIONS OF PINK JUVENILES

STREAM	YEAR	SOURCE	METHOD	TYPE OF JUVENILE	PARTICULARS OF REARING DISTRIBUTIONS
NORTH COAST					
---------- no information ----------					
SOUTH COAST					
---------- no information ----------					
FRASER R., N.B.C. and YUKON					
---------- no information ----------					

MT - Minnow Trap; SN - Seine; VI - Visual; EF - Electrofishing; DN - Dip Netting; AN - Angling; SK - Snorkeling; GN - Gill Netting

Rearing Distributions of Juveniles during New Projects Studies

Juvenile salmon were captured and recorded using a variety of means — minnow traps, seines, visual inspection, electrofishing, dipnetting, angling, snorkelling, gillnetting and combination of the above. These tables contain subjective notes on the habitat type, river location, degree of concentration and migratory roles for 0+ and 1+ juveniles. The "methods" column refers to observational methods rather than the overall strategy used to determine distribution (eg. mark-recapture). All kilometer values denote distances above the stream mouth unless otherwise indicated.

APPENDIX C-16

PHYSICAL CHARACTERISTICS OF PRIME SPAWNING AREAS Found During New Projects Studies

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Although there were large amounts of data collected in the New Projects Studies describing the physical characteristics of salmon habitats, it was not approached consistently. Study purposes often differed, from focussing on spawning or rearing capability and from addressing actual versus potential (ie. inaccessible) capability. Data collection was also extremely inconsistent, both as to the number and type of habitat parameters recorded as well as the manner in which the numbers were derived.

There was considerable variability in the manner in which habitat descriptive factors were measured. Temperature could be either a spot check or range calculation from a thermograph. Substrate size was most inconsistent, in that definitions (fines, sand, small and large gravel, cobble and boulder) varied considerably. Gravel could be considered as substrate with diameters ranging up to 15 cm. Depth, velocity and gradient were more easily quantified, although velocity (meter or drifting leaf method) may refer to surface velocity rather than velocity over the redd.

In these tables, "prime" spawning areas are generally those which contained the greatest spawner densities or those with present use/access and the best potential or suitability for spawning.

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
NORTH COAST													
Kitlope R. - reach 2	1981	Rosberg et al, 1982	8.6	6.5-11.0	-	-	10 (0-2)	— 60 — —(2-100) —		— 30 — — (>100) —		-	substrate consists largely of marginally compacted large gravel and cobble
Gamsby R. - reach 1	1981	Rosberg et al, 1982	-	-	-	-	0	0	— 100 — (unk.->100)		0	-	
Tezwa R. - reach 2	1981	Rosberg et al, 1982	approx. 10.5	8.5-13.5	40-50	70-90	0	— 60 — (2-100)		40 (100-?)	0	-	
SOUTH COAST													
Mussel Ck. - reach 4	1981	Fielden and Slaney, 1982	-	9.0-16.0	25	-	0	— 100 — (2->100)			0	-	
- reaches 2-4	1983	Whelen and Morgan, 1984	-	9.0-17.0	50-100	100-150 (at surface)	5-15 (0-1)	10-35 (1-40)	20-30 (40-100)	30 (100-300)	0-30 (>300)	$\bar{x}$ = 0.0936 max=0.112 (reach 2)	this area contained higher proportions of large gravel-cobble substrate than other surveyed reaches
Klinaklini R. - Link Ch. - Dice Ck.	1983	Whelen and Morgan, 1984	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.0034 (Link Ch.) 0.0081 (Dice Ck.)	
Ahnuhati R. - reach 4	1981	Fielden and Slaney, 1982	-	10.0-13.0*	-	-	-	-	-	most	-	-	
	1983	Whelen and Morgan, 1984	-	9.0-14.0	130	100 (at surface)	5 (0-1)	10 (1-40)	20 (40-100)	50 (100-300)	15 (>300)	0.0027	this reach and others are considerably underutilized, possibly due to competition with other salmonids for spawning/rearing habitat

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

* spot temperatures

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
SOUTH COAST - Cont'd													
Sucwoa R. - sections 9-13	1978	Glova and McCart, 1979	-	-	34-61	-	0-15 (<5)	0-100 (5-70)		0-90 (80-290)	0 (>300)	-	
Nitinat R. - sections 13-14	1979	McCart et al, 1980	-	6.5-16.0	43	30	0 (<5)	40 (5-70)		45 (80-290)	15 (<300)	-	
Little Qualicum R. - section 5c	1978	Lister, 1979	-	-	-	-	5 (0-2)	45 (2-100)		40 (>100)		-	bedrock comprised the remaining 5% of the substrate
FRASER R., N.B.C. and YUKON													
Holmes R. - reach 2	1981	Rosberg and Aitken, 1982	approx. 11.0	7.0-15.5	-	-	0 (0-2)	30 (2-100)		70 (>100)		-	the gradient ranged from 0.5-1.0% over the spawning area
Morkill R. - reach 5	1981	Rosberg and Aitken, 1982	-	6.0-14.5+	-	-	10 (0-2)	30 (2-100)		60 (>100)		-	gradient = 0.5%
Torpy R. - reach 3	1981	Rosberg and Aitken, 1982	approx. 15.0	10.5-20.0	-	-	30 (0-2)	70 (2-100)		0 (>100)		-	gradient = 0.2%
Walker Ck. - reach 1	1981	Rosberg and Aitken, 1982	approx. 12.0	11.5-17.0	-	-	20 (0-2)	80 (2-100)		0 (>100)		-	gradient = 0.5%
Slim Ck. - area 7	1980[2]	Murray et al, 1981	-	-	-	-	0.5 (0-2)	34.1 (2-16)	57.5 (16-64)	7.9 (64-254)	0 (>254)	-	
- reach 6	1981	Rosberg and Aitken, 1982	approx. 12.0	7.0-15.0+	-	-	10 (0-2)	60 (2-100)		30 (>100)		-	gradient = 0.1%

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[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] gravel composition measured for redds only

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m²	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
FRASER R., N.B.C. and YUKON - Cont'd													
Bowron R. - area 4	1980[2]	Murray et al, 1981	-	-	-	-	5.0 (0-2)	25.5 (2-16)	58.2 (16-64)	11.3 (64-254)	0 (>254)	-	
Nense Ck. - area 4	1980[2]	Murray et al, 1981	-	-	-	-	0.75 (0-2)	88.7 (2-64)		10.5 (>64)		-	
Stuart R. - Dog Ck. area	1980	Hickey and Lister, 1981	-	<12.0->16.5	150	50-100	25 (0-10)	50 (10-150)		25 (>150)		0.017	
Nechako R. - section 3	1979	Olmsted et al, 1980	0	13.0-16.0	100	see comments						-	this section characterized by intermediate velocity and abundant gravels >10 cm in diameter
West Road R. - section 2	1980	Olmsted et al, 1981	-	13.5 (spot temp. taken Sept. 9)	150	-	5	90		5		<0.0001	flow pattern primarily riffle-type
Nazko R.	1980	Olmsted et al, 1981	-	14.0 (spot temp. taken Aug. 29)	100	-	0 (0-2)	100 (2-150)		0 (>150)		0.0002	riffles are predominant flow-type
Cottonwood R. - section 1	1980	Olmsted et al, 1981	-	<10.0->12.0	150	-	5 (0-2)	90 (2-150)		5 (>150)		0.0010	riffles are predominant flow-type
Horsefly R. - sections 2 & 3	1979	Olmsted et al, 1980	-	-	approx. 100	see comments	-	-	-	-	-	-	flows are of "intermediate" velocity and gravels <10 cm in diameter are abundant.
	1980	Olmsted et al, 1981	approx. 12.0	11.5-12.0	200	-	10 (0-2)	90 (2-150)		0 (>150)		0.010	riffles are predominant flow-type

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] gravel composition measured for redds only

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m²	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
FRASER R., N.B.C. and YUKON - Cont'd													
McKinley Ck. - section 3	1980	Olmsted et al, 1981	approx. 15.5	approx. 15.0-16.0	150	-	5 (0-2)	90 (2-150)		5 (>150)		approx. 0.006	riffles are predominant flow-type
Quesnel R.	1979	Olmsted et al, 1980	approx. 14.0	12.5-15.0	approx. 150-200	see comments						-	flows are intermediate to fast and substrates are variable (mostly <10 cm in section 1 & sand/gravel/boulder in section 4)
	1980	Olmsted et al, 1981	13.0	11.0-14.0	100-1000+	-	30 (0-2)	50 (2-150)		20 (>150)		0.086	20% of the substrate was composed of bedrock; flow character was 50% pool and 50% run
Eagle R. - section 7	1981	Whelen and Olmsted, 1982	-	10.5-18.0	38	-	10	60		30		0.202	gravels between 50 and 150mm in diameter were preferred
Salmon R. - section 8	1981	Whelen and Olmsted, 1982	-	<7.0-21.0	100	-	79	19		2		0.032	gravels from 10-75mm in diameter were utilized due to lack of larger substrates
Adams R. (lower) -section 4	1981	Whelen and Olmsted, 1982	20.0	10.0-20.0	300	-	0	30		70		0.0045	gravels between 10 and 200mm in diameter were utilized, runs are predominant flow type
South Thompson R. - section 5 - section 6	1981	Whelen and Olmsted, 1982	approx. 15.0 approx. 15.0	8.0-21.0 8.0-21.0	1000+² 3000+²	- -	10 85	80 10		10 5		0.090 0.255	gravels between 10 and 150mm in diameter were utilized gravels between 50 and 150mm in diameter were utilized
Finn Ck. - section 2	1981	Scott et al, 1982	12.5	9.0-16.5	40	-	5	15		55	25	0.060	moderate flows and gravels between 50 & 150mm in diam. preferred
Raft R. - section 2	1981	Scott et al, 1982	13.5	11.0-18.5	70	-	25	65		5	5	0.0225	moderate flows and gravels between 50 & 150mm in diameter were preferred
North Thompson R. - section 2	1981	Scott et al, 1982	-	-	200	-	30	60		10	0	0.0024	flow is entirely run-type

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[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] Maximum depth.

PHYSICAL CHARACTERISTICS OF PRIME COHO SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP. (°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
						NORTH COAST							
Mathers Ck. - section 11-12	1978	Glova et al, 1979	-	approx. 5.0-11.5	<100	-	10 (0-5)	—90— (5-70)		0 (80-290)	0 (>300)	-	spawning was conducted in flows of moderate velocity; substrate scoured to 25cm depth during spawning
Gamsby R. - reach 1	1981	Rosberg et al, 1982	-	-	-	-	-	-	— most —		-	-	pool/riffle ratio was 1:19
Kowesas R. - reach 2	1981	Rosberg et al, 1982	<6.0	-	-	-	-	-	-	-	-	-	areas containing suitable spawning gravel were intermittent and well-utilized; gradients range from 2-5%
Tsaytis R. - reach 2	1981	Rosberg et al, 1982	-	-	-	-	-	-	— most —		-	-	spawning occurred in deep water and substrates of mixed gravel & cobble, typically in close proximity to groundwater inflow points; gradient = <5%
						SOUTH COAST							
Glendale/Tom Browne Cks.	1983	Whelan and Morgan, 1984	-	-	-	-	-	-	-	-	-	-	although there exists 55100m^2 of potential habitat and past escapements have averaged 2400 fish (@0.0436 fish/m^2), no fish were observed in 1983, likely due to displacement by large numbers of pinks

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

PHYSICAL CHARACTERISTICS OF PRIME COHO SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
SOUTH COAST - Cont'd													
Mussel Ck. - reach 7	1983	Whelen and Morgan, 1984	-	<9.0-10.0	50	70 (at surface)	25 (0-1)	25 (0-40)	30 (40-100)	15 (100-300)	5 (>300)	0.0960	this section contained the highest proportion of riffle flow (50%) and side channel area.
Klinaklini R. - Link Channel	1983	Whelen and Morgan, 1984	-	<3.5-6.0	70	50 (at surface)	25 (0-1)	15 (1-40)	25 (40-100)	35 (100-300)	<2 (>300)	0.0333	spawning density was near optimum
- Dice Creek			-	-	40	70 (at surface)	10 (0-1)	40 (1-40)	30 (40-100)	20 (100-300)	>2 (>300)	0.0091	spawning density was approx. 30% of optimum
Ahnuhati R. - reach 6	1983	Whelen and Morgan, 1984	-	-	100	70 (at surface)	10 (0-1)	30 (1-40)	35 (40-100)	25 (100-300)	>5 (>300)	-	although spawning had not begun by project termination, potential was greatest of any reach & holding fish were abundant
FRASER R., N.B.C. and YUKON													
Eagle R. - section 13	1982	Whelen et al, 1983[2]	3.8	2.0-5.0	30	50	10	35	30	20	5	0.0726	spawner density at 90% of optimum
Salmon R. - section 8	1982	Whelen et al, 1983[2]	1.6	0.0-6.0	50	40	50	15	30	<5	>1	0.0340	spawner density at 67% of optimum
Adams R. (lower) - section 5	1982	Whelen et al, 1983[2]	5.5	4.5-7.0	400	-	0	10	30	20	10	0.0004	utilization was low, however, suitable habitat was more extensive than in other sections

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] Assume Whelen and Morgan (1984) substrate sizes.

PHYSICAL CHARACTERISTICS OF PRIME COHO SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m²	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
FRASER R., N.B.C. and YUKON - Cont'd													
Adams R. (upper) - Cayenne Ck.	1982	Whelen et al, 1983[2]	1.5	-	50	80	30	40	25	5	0	0.050	density of spawners was twice that of optimum
Albreda R. - reach 2	1982	Hutton et al, 1983	-	approx. 0.5-1.0	-	-	see comments					-	100% of substrate under cobble size
Lion Ck. - reach 2	1982	Hutton et al, 1983	-	approx. 3.5-10.0	50	-	see comments					-	substrate is mainly gravels with lesser proportions of fines and cobbles
Wire Cache Ck. - lower 300 m	1982	Hutton et al, 1983	-	> 0.0	50	0	100 (0-40)		0	0	0	-	
Lemieux Ck. - reach 3B	1982	Hutton et al, 1983	-	0.00-2.0	30	-	see comments					-	substrate consists of fines, gravels and smaller cobble, in varying proportions
Barriere R. - reach 1	1982	Hutton et al, 1983	-	2.0-3.0+	-	-	see comments					-	substrate is mainly fines along shorelines, tending to coarser material (gravel-boulder) towards mid-stream; flows are slow & depth is great
Louis Ck. - reach 1	1982	Hutton et al, 1983	-	2.0 -approx. 9.0	-	-	see comments					-	substrate consists of suitable gravel interspersed by areas of fines
Coldwater R.	1982	Whelen et al, 1983[2]	1.0	0.0 - 2.0	40	50	<5	25	40	30	<5	0.0045	spawner density was 17% of optimum

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] Assume Whelen and Morgan (1984) substrate sizes.

PHYSICAL CHARACTERISTICS OF PRIME CHUM SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
						NORTH COAST							
Mathers Ck. - section 10-11	1978	Glova et al, 1979	-	9.5 - 14.5	≤ 100	-	30 (0-5)	70 (5-70)		0 (80-290)	0 (>300)	-	many pools and short glides of moderate velocity are present
Kitlope R. - reach 2	1981	Rosberg et al, 1982	approx. 8.0	7.0-9.0	<50	-	10 (0-2)	60 (2-100)		30 (>100)		-	spawning occurred in side channels partially fed by tributary streams
Kemano R. - reach 2	1979[2]	Murray and Hamilton, 1981	-	8.0-14.0	-	-	5.5 (0-2)	12.1 (2-20)	70.6 (20-64)	11.8 (>64)		-	approx. 30% of available habitat was utilized
Kwatna R.	1983	Rice, 1984	approx. 9.5	5.0-12.5	-	-	20 (0-2)	70 (2-64)		10 (> 64)		-	stream channilized; many mid-stream bars present; x gradient = 0.1%; flow mainly riffle/glide.
Oak-Beck Ck.	1983	Rice, 1984	-	-	-	-	10 (0-2)	90 (2-64)		0 (> 64)		-	flow character pool/riffle; gradient approx. 0.05%.
Quatlena R.	1983	Rice, 1984	approx. 11.0	8.0-16.5	-	-	20 (0-2)	70 (2-64)		10 (> 64)		-	this area tidally influenced; gradient = 0.5%; mainly riffle/glide mainly pool/glide.
Nootum R.	1983	Rice, 1984	approx. 8.5	5.0-13.0			10 (0-2)	40 (2-64)		50 (> 64)		-	lower portion of area is tidal; gradient approx. 1.0; flow character mainly pool/glide.
						SOUTH COAST							
Kakweiken R. - section 10	1981	Slaney and Milko, 1982	-	approx. 7.0-12.0	-	-	100 (0-75)			0	0	-	this is a low gradient area consisting of a series of long shallow glides running between pools

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] gravel composition measured for redds only

PHYSICAL CHARACTERISTICS OF PRIME [illegible] SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP. (°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
						SOUTH COAST - Cont'd							
Tom Browne Ck. - reach 2	1983	Whelen and Morgan, 1984	-	<8.0-15.0	30	50 (at surface)	10 (0-5)	25 (1-40)	30 (40-100)	30 (100-300)	5 (>300)	0.1772	habitat was apparently over-utilized
Mussel Ck. - reach 2	1981	Fielden and Slaney, 1982	-	<7.5-12.0	50	-	-	-	-	-	-	-	substrate described as gravel; flows swift; gradient 2%
- reach 2	1983	Whelen and Morgan, 1984	-	approx. 8.0-11.0	100	100 (at surface)	5 (0-1)	35 (1-40)	35 (40-100)	30 (100-300)	0 (>300)	approx. 0.040	
Klinaklini R. - Link Channel	1983	Whelen and Morgan, 1984	-	3.0-6.0	70	50 (at surface)	25 (0-1)	15 (1-40)	25 (40-100)	35 (100-300)	>2 (>300)	0.0294	optimal density is likely much higher than that observed
Ahnuhati R. - reach 2a & 2b	1981	Fielden and Slaney, 1982	approx. 11.0	10.0-13.0	approx. 100	-	-	-	-	-	-	-	areas of glide and riffle flow contain mainly gravel/cobble, while fines predominate in deeper pools.
- reach 3	1983	Whelen and Morgan, 1984	-	9.0-14.0	100	150 (at surface)	5 (0-1)	10 (1-40)	20 (40-100)	30 (100-300)	35 (>300)	0.1780	
- reach 2c			-	9.0-14.0	80	80 (at surface)	5 (0-1)	30 (1-40)	40 (40-100)	20 (100-300)	5 (>300)	0.1571	
Sucwoa R. - sections 6-8 & 9-12	1978	Glova and McCart, 1979	-	8.5-14.5	>50	30-50	-	-	-	-	-	-	medium-sized gravels <100mm in diameter were preferred

[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

PHYSICAL CHARACTERISTICS OF PRIME CHUM SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
					SOUTH COAST - Cont'd								
Canton Ck. - four locations within sections 2-7	1978	Glova and McCart, 1979	-	2.0-14.0	-	-	-	-	-	-	-	-	preferred locations exhibited a glide/riffle flow, intermediate velocity and depth and medium-sized gravels
Conuma R. - several locations in sections 3-7	1978	Glova and McCart, 1979	-	approx. 10.5-12.0	- -	- -	- -	- -	- -	- -	- -	- -	riffle areas with gravel bottoms and intermediate velocities and depths were preferred
Tlupana R. - sections 5 & 7-13	1978	Glova and McCart, 1979	-	approx. 9.0-12.5	-	-	-	-	-	-	-	-	gradients are slight and suitable spawning gravels abundant in these sections
Deserted Ck. - accessible portion	1978	Glova and McCart, 1979	-	2.5-16.0	<30	-	-	-	-	-	-	-	a portion of the spawning area is intertidal
Little Qualicum R. - section 1	1978	Lister, 1979	-	4.0-10.0	-	-	10-20 (0-2)	—50-70— (2-100)		20-25 (>100)		2.0-2.6	maximum density occurred in section 4, where 8.6 fish/m^2 spawned

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[1] figures within brackets indicate the range in diameter assigned to each substrate category

- where figures are absent source report has not provided a breakout in substrate sizes

PHYSICAL CHARACTERISTICS OF PRIME SOCKEYE SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m²	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
NORTH COAST													
Tezwa R. - reach 2	1981	Rosberg et al, 1982	approx. 9.5	7.0-12.5	-	-	10 (0-2)	——20—— (2-100)		——80—— (>100)		-	substrate is free of silt
Kalitan Ck. - reach 1	1981	Rosberg et al, 1982	-	-	-	-	10 (0-2)	——20—— (2-100)		——80—— (>100)		-	pool/riffle ratio = 1:1.5
Kwatna R.	1983	Rice, 1984	approx. 6.5	4.0-8.5	-	-	20 (0-2)	——70—— (2-64)		——10—— (> 64)		-	stream channelized; many mid stream bars; $\bar{x}$ gradient = 0.1%; flow character predominantly riffle/glide.
SOUTH COAST													
Kakweiken R. - reach 9₄	1981	Slaney and Milko, 1982	-	approx. 11.0-15.0	-	-	-	-	-	-	-	-	this 600m area consists of a series of narrow, shallow glides and fast, shallow riffles
Mussel Ck. - reach 4	1983	Whelen and Morgan, 1984	-	approx. 10.0-14.0	50	100 (at surface)	15 (0-1)	20 (1-40)	30 (40-100)	30 (100-300)	5 (>300)	-	
FRASER R., N.B.C. and YUKON													
Adams R. - section 3	1981	Whelen and Olmsted, 1982	-	approx. 10.0-12.0	250[2]	-	0	——40——		——60——		-	
South Thompson R. - Little R.	1981	Whelen and Olmsted, 1982	-	8.0-17.0	3000+[2]	-	0	——40——		——60——		-	flows are moderate to fast
Raft R. - sections 1 & 2	1981	Scott et al, 1982	-	11.5 - approx. 15.0	50-70	-	25	——65——		5-10	0-5	-	

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[1] figures within brackets indicate the range in diameter assigned to each substrate category
- where figures are absent source report has not provided a breakout in substrate sizes

[2] these figures are suspect

PHYSICAL CHARACTERISTICS OF PRIME PINK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m^2	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
						NORTH COAST							
Mathers Ck. - sections 9-11 & 1-6	1978	Glova et al, 1979	-	9,5 - 14,5	-	-	-	-	-	-	-	-	preferred substrates were <50mm in diameter
Fukawa Ck. - section 16-17	1978	Glova et al, 1979	-	≤7,0->9,0	-	-	90	10		0	0	-	preferred substrates were <50mm in diameter
Kwatna R.	1983	Rice, 1984	approx. 8,5	5,0-11,5	-	-	20 (0-2)	30-70 (2-64)		10-50 (> 64)		-	flow character predominantly riffle/glide; gradient = 0,05 - 0,1%.
Gus Ck.	1983	Rice, 1984	<10,0	<9,0-12,5	-	-	10 (0,2)	80 (2-64)		10 (> 64)		-	flow character is pool/riffle; gradient = 0,5%.
Oak-Beck Ck.	1983	Rice, 1984	-	-	-	-	10 (0-2)	90 (2-64)		0 (> 64)		-	flow consists mally of riffle; gradient = 0,5%.
Slowiska Ck.	1983	Rice, 1984	approx. 10,0	>6,5-13,0	-	-	20 (0-2)	80 (2-64)		0 (> 64)		-	flow character mainly riffle/pool; gradient = 0,5%
Glacier Ck.	1983	Rice, 1984	-	-	-	-	10 (0-2)	30 (2-64)		60 (> 64)		-	flow consists of riffle and rapids; gradient = 0,5%
Quatlena R.	1983	Rice, 1984	approx. 9,5	6,0-16,5	-	-	20 (0,2)	70 (2-64)		10 (> 64)		-	flow is mainly riffle/glide; gradient = 0,5%.
Nootum R.	1983	Rice, 1984	approx. 8,5	5,0-14,5	-	-	10 (0-2)	40 (2-64)		30 (>64)		-	flow is predominantly pool/glide; gradient is 1,0%
						SOUTH COAST							
Glendale Ck. - reaches 3-6	1983	Whelan and Morgan, 1984	-	8,0-21,5	40-70	30-80 (at surface)	x=23 range= 5-75 (0-1)	x=24 range= 5-75 (1-40)	x=20 range= 5-35 (40-100)	x=25 range= 5-35 (100-300)	x=9 range= <1-25 (>300)	x=6,882 range= 5,598-8,170	these reaches were over-utilized and redd superimposition was observed

[1] figures within brackets indicate the range in diameter assigned to each substrate category

[2] this figure is highly suspect

PHYSICAL CHARACTERISTICS OF PRIME PINK SPAWNING AREAS

STREAM	YEAR	SOURCE	TEMP.(°C) DURING SPAWNING		$\bar{x}$ DEPTH (cm)	VELOCITY (cm/sec)	SUBSTRATE COMPOSITION[1] % (mm)					SPAWNERS/m²	COMMENTS
			$\bar{x}$	Range			Fines	Small Gravel	Large Gravel	Cobble	Boulder		
SOUTH COAST - Cont'd													
Tom Browne Ck. - reach 1	1983	Whelen and Morgan, 1984	-	-	40	40-60 (at surface)	10 (0-1)	30 (1-40)	45 (40-100)	15 (100-300)	<1 (<300)	3,459	spawning areas were over-utilized
- reach 2			-	-	30	50 (at surface)	10 (0-1)	25 (1-40)	30 (40-100)	30 (100-300)	5 (<300)	5,400	spawning areas were over-utilized
Ahnuhati R. - reach 2	1981	Fielden and Slaney, 1982	10,3	10,0-13,0	-	-	-	-	-	-	-	-	spawning was conducted along long, shallow glides; much of the substrate is composed of gravel and cobble
- reach 3	1983	Whelen and Morgan, 1984	-	6,5-14,0	100	150 (at surface)	5 (0-1)	10 (1-40)	20 (40-100)	30 (100-300)	35 (>300)	0,3864	combined pink and chum spawner densities approached the optimum level
- reach 2c	1983	Whelen and Morgan, 1984	-	6,5-14,0	80	80 (at surface)	5 (0-1)	30 (1-40)	40 (40-100)	20 (100-300)	5 (<300)	0,2107	combined pink and chum spawner densities approached the optimum level
FRASER R., N.B.C. and YUKON													
South Thompson R. - section 4	1981	Whelen and Olmsted, 1982	-	8,07-17,0	500+[2]	-	5	90		5		-	

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[1] figures within brackets indicate the range in diameter assigned to each substrate category

[2] this figure is highly suspect

NOTES TO ACCOMPANY PHYSICAL CHARACTERISTICS OF PRIME SPAWNING AREAS TABLE

1. "Prime" spawning areas are generally those which contained the greatest spawner densities or those with present use/access and the best potential or suitability for spawning.

APPENDIX C-17

PHYSICAL CHARACTERISTICS OF PRIME REARING AREAS Found During New Projects Studies

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See APPENDIX C-16. Values for depth, velocity and fry density were derived from sampling methods that varied considerably between and within New Projects studies. In addition, these values were developed as an average or mode of conditions for a stream section or reach, rather than on a microhabitat basis. Physical characteristics of the habitats consists mostly of subjective descriptions of macrohabitat. The reader is advised that as sampling methods varied considerably, the fry per square meter figures should be treated simply as a general indicator of fry density.

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
NORTH COAST									
Morice R.	1979[1]	Smith and Berezay, 1983	0+	various	various	"slow"	logs/debris	-	-
Kitimat R. (tribs.)	1980[2]	Birch et al, 1981	0+	deep pools "associated with current" and unspecified overhanging cover	-	-	-	-	-
SOUTH COAST									
				no information					
FRASER R., N.B.C. and YUKON									
Fraser R. (mainstem)	1981	Rosberg et al, 1982	0+	various, including backwaters, side channels, shoreline debris accumulations -the river meanders and has a low velocity.	-	-	-	high turbidity as a form of cover	-
Holmes R.	1981	Rosberg et al, 1982	0+	-backwater areas, frequently associated with extensive debris dams.	-	-	-	-	-
Morkill R.	1981	Rosberg et al, 1982	0+	-although not considered as preferred habitat, river margins and slow flowing sections along the inside of meanders were utilized by the majority of rearing fry, as more suitable conditions were, at best, transient with water level. -gradient averages 0.1% -flow character often swirling	- -	-	fines	-	-
Torpy R.	1981	Rosberg et al, 1982	0+	-slow flow areas, undercut banks and debris accumulations preferred rearing sites.	-	-	usually small gravel or fines		-
Slim Ck.	1981	Rosberg et al, 1982	0+	-generally, backwater areas, beaver ponds and lakeshore habitats were preferred; Slim Lake constituted a major rearing area.	-	nil - slow	-	-	-
Bowron R. (tribs.)	1980	Murray et al, 1981	0+	-until July areas with dense cover, sand and gravel substrate and run/riffle/pool flow, were preferred after which areas exhibiting larger substrates appeared to be preferred.	-	-	-	-	-

[1] Highest mean catches of fry occurred in differing habitats, depending on the sampling period; the information given in the table depicts overall trends and, where information is not given, no trends were evident.

[2] Describes the preferred habitat of summer fry in Cecil and Hirsch Creeks and represents a change from that which was preferred in the spring. Spring habitats were not described, however.

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MICRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m²
				FRASER R., N.B.C. and YUKON - Cont'd					
Stuart R.	1980	Lister et al, 1981	0+	-highest fry densities occurred in areas of gently sloping or level substrate with slow to moderately-flowing current (mainstem)[3],[4]	60 - 100	0 - 30	-	-	max = 0.012
Nechako R.	1979	Olmsted et al, 1980	0+	-concentrations of fry were typically found in backwaters or areas with sluggish flow	< 100	nil - slow	generally fines and/or small gravel	high canopy cover, ie. deciduous trees.	
Swanson Ck.	1979	Olmsted et al, 1980	0+	-	<50	moderate - fast	cobble	mixed deciduous and coniferous trees	-
Horsefly R.	1979	Olmsted et al, 1980	0+	slow riffle and pool areas were preferred.	approx 100	nil - slow	sand/gravel	low alder/willow.	
Quesnel R.	1979	Olmsted et al, 1980	0+	-	1000	approx 100	boulder/mud	grasses/alder	-
	1980	Whelan et al, 1981	0+	-riffle is the predominating flow type	200	fast	gravel	alder/willow	-
Middle Shuswap R.	1983	Fee and Jong, 1984	un-specified	-habitat preference appeared to be linked with discharge; with moderate to high water level and turbidity, sidechannels with velocities not exceeding 30 cm/sec. were most-utilized. As levels dropped, deepwater habitats associated with log debris were preferred, the larger and more complex the debris site and the greater the velocity, the higher the density of juveniles become.	-	moderate - fast	gravel	log debris & over stream vegetation	-[5]
Bossette Ck. System	1983	Fee and Jong, 1984	un-specified	primary rearing locations were situated in relatively deep pool/glide habitats with low velocity and good cover.	-	slow	gravel	log/cutbank	0.18-0.61 g/m²
Trinity Ck.	1982	Sebastien, 1983	0+	the area most suitable for rearing exhibits low gradient (0.5%), shallow riffles and glides and some channelization.	-	-	gravel	log debris, overstream vegetation	-
Eagle R.	1981	Whelan et al, 1982	0+	prime rearing areas have predominantly a run-type flow character.	$\bar{x}$ = 65-180	-	gravel	overhanging vegetation	-

[3] Accompanying parameters are representative of the sampling station with the highest overall fry density/m². However, the number of fry/m² is indicative only of the highest daily catch.

[4] It should be noted that tributary streams often contained much higher densities of fry than the mainstem but macro-habitat characteristics were not explained. The most notable of these were Creek A, Welch Creek and Kee Creek, whose respective peak (site-specific) fry densities were: 0.082/m², 0.046/m² and 0.043/m².

[5] The report lists only an estimate of abundance for the whole anadromous length of stream; this figure is 1.0-7.0g/m² of Σ 0+ and 1+ fish biomass.

PHYSICAL CHARACTERISTICS OF FRY CHINOOK REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				FRASER R., N.B.C., and YUKON - Cont'd					
Crazy Ck.	1982	Sebastian, 1983	0+	the area contains a riffle/glide flow, and a gradient described as low (4%)	-	-	gravel/cobble	overstream vegetations & log debris	-
Perry R.	1982	Sebastian, 1983	0+	rearing fish are restricted to a small side-channel area and to stream margins.	-	100	gravel/cobble	log debris and boulders	-
Salmon R.	1981	Whelan et al, 1982	0+	flow character is riffle/run, often in or near debris accumulations.	$\bar{x}$ = 75-100	-	gravel	chiefly overhanging vegetation	-
Seymour R.	1982	Sebastian, 1983	0+	primary rearing areas were typically located in side channels, often in association with log debris in low gradient situations[2].	-	<40	gravel	log debris	-
Adams R.	1981	Whelan et al, 1982	0+	flow character is predominantly run	400	-	gravel	overhanging vegetation and high canopy	-
South Thompson R.	1981	Whelan et al, 1982	0+	lake foreshore	-	nil	fines	some canopy	-
Blue R.	1981	Scott et al, 1982	0+ & 1+	flow type is predominantly run in the main channel, but rearing typically in backwaters and along margins of channel	50	-	gravel/cobble	overhanging vegetation	-
Finn Ck.	1981	Scott et al, 1982	0+	the predominating flow types were runs and riffles	30	-	gravel/cobble	overstream vegetation & log debris	-
	1982	Stewart et al, 1983	0+	suitable flows typically consisted of riffles	-	-	gravel/cobble	overhanging vegetation	0-0.025
Lion Ck.	1981	Scott et al, 1982	0+	riffle-run flow.	30	-	gravel	overhanging vegetation	-
Raft R.	1981	Scott et al, 1982	0+	gradient moderate, flow velocity moderate, flow character run/riffle/pool.	70	-	gravel	overhanging vegetation & canopy; both extremely limited	-
	1982	Stewart et al, 1983	0+	see above	-	-	gravel/sand	cutbanks & log debris	0-0.036
Clearwater R.	1982	Stewart et al, 1983	0+	-	-	-	cobble/boulder	overstream vegetation & log debris	0-0.028

PHYSICAL CHARACTERISTICS OF PRIME CHINOOK REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				FRASER R., N.B.C. and YUKON - Cont'd					
North Thompson R.	1981	Scott et al, 1982	0+	flow character typically 100% run.	approx 200	-	gravel	various	-
			1+	as above.	200-250	-	gravel	very little	-
	1982	Stewart et al, 1983	0+	-	-	-	gravel	log debris & undercut banks	0-0.0224

PHYSICAL CHARACTERISTICS OF PRIME COHO REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
NORTH COAST									
Kitimat R. & Tribs.	1980	Birch et al, 1981	0+	preferred areas were shallow side channels and pools.	shallow	slow	-	-	-
			1+	smolts typically were found in slow current situations, ie. backchannels or pools.	-	slow	-	overhanging veg. or instream debris	-
Kwatna R.	1983	Rice, 1984	un-specified	the majority of the juveniles encountered were situated in pools associated with root wads and debris jams	-	slow	-	instream debris	-
Gus Ck.	1983	Rice, 1984	un-specified	1 pool at the mouth of the stream contained most of the observed juveniles.	< 150	slow	-	log debris	-
SOUTH COAST									
Oak-Beck Ck	1983	Rice, 1984	un-specified	suitable rearing was offered by extensive windfall, instream debris and overstream cover areas.	-	-	-	various	-
Glendale/Tom Browne Cks.	1983	Whelen and Morgan, 1984	0+ & 1+	pool habitat was preferred	-	-	-	-	-
Mussel Ck.	1983	Whelen and Morgan, 1984	0+ & 1+	most captures of juveniles were made in large pools	-	-	-	-	-
FRASER R., N.B.C. and YUKON									
Horsefly R.	1979	Olmsted et al, 1980	un-specified	area consisted of riffle/pool flow.	<100	slow	gravel/cobble	alder/willow - overstream cover.	-
Quesnel R.	1980	Whelen et al, 1981	0+	area consists of fast riffle flow	200-300	fast	gravel/cobble	low canopy on bar, sidechannel margins.	-
Middle Shuswap R.	1983	Fee and Jong, 1984	0+	at low flows, coho fry were found only in association with log debris but no preference was given to the size and complexity of the debris sites, as was the case with chinook.	-	-	gravel	mainly log debris	-

PHYSICAL CHARACTERISTICS OF PRIME COHO REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				FRASER R., N.B.C. and YUKON - Cont'd					
Bessette Ck. System	1983	Fee and Jong, 1984	0+	-juveniles found throughout preferred glide -riffle habitats, except where cover was poor			gravel	log debris, overstream veg. & cutbank.	-
Trinity Ck.	1982	Sebastian, 1983	0+	riffle/pool habitats in association with good cover offer excellent rearing	-	-	gravel	primarily log debris, secondarily overstream veg. & undercut banks.	
Eagle R.	1981	Whelen et al, 1982	0+	areas of greatest fry occurrance had normally a run flow character but riffle and pool areas were common also.	$\bar{x}$ = 25-125	-	gravel	typically overhead canopy	-
			1+ & 2+	flow type typically run/pool	$\bar{x}$ = 50-65	-	gravel	overhang predominant	-
South Pass Ck.	1982	Sebastian, 1983	0+ & 1+	most rearing likely occurs in pool/riffle habitats in the lower portion of stream	20	-	gravel	overhang & canopy roughly equivalent and abundant.	-
Crazy Ck.	1982	Sebastian, 1983	0+	best rearing conditions are afforded in pools and slow glides, which are extremely limited.	-	-	>10 cm	limited overstream veg. and log debris.	-
Perry R.	1982	Sebastian, 1983	0+	rearing is restricted to sidepools and narrow sections of stream margins		<40	gravel, cobble, boulder	log debris, boulders	-
Salmon R.	1981	Whelen et al, 1982	0+	riffle/run flow pattern predominated in areas of concentrated rearing.	$\bar{x}$ = 75-80	-	gravel	primarily overhang, frequent canopy cover	-
			1+	flow consists of long runs	40	-	fines	canopy and overhang (mainly grass)	-
Tappen Ck.	1982	Sebastian, 1983	0+	riffle/glide habitats with abundant cover form suitable rearing areas.	-	-	fines	overstream veg.	-
Seymour R.	1982	Sebastian, 1983	0+ & 1+	concentrations occurred along shore margins	-	<40	gravel	log debris, overstream veg.	0.8[6]
McNomee Ck.	1982	Sebastian, 1983	0+ & 1+	low velocity pool and glide areas associated with complex log cover	-	-	gravel, large	primarily log debris	0.54[6]

[6] Figures represent maximum site - specific densities

PHYSICAL CHARACTERISTICS OF PRIME COHO REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				FRASER R., N.B.C. and YUKON - Cont'd					
Adams R.	1981	Whelen et al, 1982	0+	flow character is run/riffle	x = ≤ 20	-	gravel	high degree of both canopy and overhanging veg.	-
South Thompson R.	1981	Whelen et al, 1982	0+ & 1+	lake foreshore area and slow runs in river	-	nil - slow	fines/gravel	very little	-
Albreda R.	1982	Hutton et al, 1983	0+	rearing is chiefly conducted along sections exhibiting undercut banks or debris accumulations.	$\bar{x}$ = 80	slow	fines/gravel	primarily log debris, many undercut banks	-
Blue R.	1981	Scott et al, 1982	0+ & 1+	-	50	-	gravel/cobble	overhanging vegetation	-
Goose Ck.	1982	Hutton et al, 1982	un-specified	sheltered, slow glides provide good rearing habitat	-	slow	fines	undercut banks, low overstream vegetation	-
Paddle Ck.	1982	Hutton et al, 1982	0+ & 1+	glide sections between beaver dams well-utilized	-	slow	fines	low overstream veg.	-
Finn Ck.	1981	Scott et al, 1982	0+ & 1+	streamflow consists primarily of runs	30	-	cobble	occasional overhanging veg.	-
	1982	Stewart et al, 1983	0+	lower flow velocities and good cover, especially in sidechannels, provide good habitat	-	fast	gravel/cobble	log debris, abundant bank veg.	0-0.025
Lion Ck.	1981	Scott et al, 1982	0+ & 1+	pools and backwater areas associated with broken beaver dams are preferred rearing areas.	30	-	gravel	overhanging veg.	-
Wire Cache Ck.	1982	Hutton et al, 1983	0+ & 1+	small pools and riffles associated with undercut banks and small debris accumulations and overhanging vegetation provided a suitable rearing environment.	approx 20	generally slow	small gravel	overhanging veg., instream debris & undercut banks.	-
Raft R.	1981	Scott et al, 1982	0+	the area is characterized by a riffle/run flow and occasional deep pools. -debris and root wads along sections of stream margins offered suitable rearing habitat.	40	slow	gravel	overhang & canopy: both limited	-
Clearwater R.[7]	1982	Stewart et al, 1983	1+	utilization was highest in margin areas where flow was slow.	-	fast	boulder/bedrock	none present	0-0.006

[7] As catches were only recorded in April, these yearlings may have been emigrating.

PHYSICAL CHARACTERISTICS OF PRIME COHO REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				FRASER R., N.B.C., and YUKON - Cont'd					
Dunn Ck.	1982	Stewart et al, 1983	0+ & 1+	use was highest in backeddies containing organic debris; the section as a whole exhibits a riffle/glide flow character	-	-	gravel	limited over. stream veg.	0-0.2 (fry)
McTaggart Ck.	1982	Stewart et al, 1983	0+	riffle/pool flow along meanders offers good rearing habitat.	-	-	gravel/sand	extensive canopy, instream debris	0.015 - 0.058
Lemieux Ck.	1982	Stewart et al, 1983	0+ & 1+	sidechannels and backwaters in association with log debris, offer moderately good rearing.	-	-	gravel/cobble	undercut banks and log debris	0.003 - 0.173 (fry) 0-0.013 (yearlings)
Barriere R.	1982	Stewart et al, 1983	0+	many sidechannels and back-eddies are present and the stream is fairly turbid. -flow is swift through a deep mainchannel.	-	-	cobble	bank vegetation (extensive, aquatic vegetation	1.17-2.06
Louis Ck.	1982	Hutton et al, 1983	0+ & 1+	habitat appears suitable in sections where logjams, windfalls and beaver dams occur.	-	-	gravel	overstream veg., canopy, log debris	-

PHYSICAL CHARACTERISTICS OF PRIME CHUM REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				NORTH COAST					
				No Information					
				SOUTH COAST					
				No Information					
				FRASER R., N.B.C. and YUKON					
				No Information					

PHYSICAL CHARACTERISTICS OF PRIME SOCKEYE REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
NORTH COAST									
				No Information					
SOUTH COAST									
				No Information					
FRASER R., N.B.C. and YUKON									
Quesnel R.	1980	Whelen et al, 1981	0+	river widens to a narrow lake in this area	1000	approx 100	boulder/mud	grasses, low and high canopy	-
Eagle R.	1981	Whelen et al, 1982	0+	the river flow is mainly runs	200	slow	fines/gravel	overhanging veg. & canopy	-
Salmon R.	1981	Whelen et al, 1982	0+	-	$\bar{x}$ = 40-100	-	fines (lower area) gravel (upper area)	overhanging veg. (fairly abundant canopy (limited)	-
South Thompson R.	1981	Whelen et al, 1982	0+ & 1+	Little Shuswap and Shuswap Lake foreshores	-	nil	fines/gravel	limited canopy, very limited overhanging veg	-
Raft R.	1981	Scott et al, 1982	0+	flow character is riffle/run/pool/	70	moderate	gravel	very limited canopy & overhanging vegetation, several debris accumulations.	-
North Thompson R.	1981	Scott et al, 1982	0+	the flow is primarily long runs.	$\bar{x}$ = 200-300	-	gravel	Instream debris and [8] extensive bank vegetation (sidechannels).	-
	1982	Stewart et al, 1983	1+	-	-	-	gravel	Instream debris; overhanging veg. (primarily in sidechannels).	0.014-0.203

[8] From Stewart et al (1983)

PHYSICAL CHARACTERISTICS OF PRIME PINK REARING AREAS

STREAM	YEAR	SOURCE	TYPE OF JUVENILE	MACRO HABITAT DESCRIPTION	DEPTH (cm)	FLOW (cm/sec)	DOMINANT SUBSTRATE	TYPES OF COVER	FRY/m^2
				NORTH COAST					
				No Information					
				SOUTH COAST					
				No Information					
				FRASER R., N.B.C. and YUKON					
				No Information					